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Factors associated with malaria among 3 to 59 months old children in Boromo and Gaoua Health Districts, Burkina, 2020

KEYWORDS: Malaria, SMC, Associated factors

Pauline Kiswendsida Yanogo[1,2,&], Chantal Yanogo[2], Halidou Tinto[3]

[1]Department of Public Health, Unité de recherche et de formation en science de la santé, Université Joseph Ki Zerbo, Ouagadougou, Burkina Faso, [2]Burkina Field Epidemiology and Laboratory Training Program (BFELTP), Université Joseph Ki Zerbo, Ouagadougou, Burkina Faso, [3]Clinical Research Unit of Nanoro, Institut de Recherche en Sciences de la Santé, Nanoro, Burkina Faso

&CORRESPONDING AUTHOR
Pauline Kiswendsida Yanogo[1,2,&], Chantal Yanogo[2], Halidou Tinto[3]

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ABSTRACT

Introduction: Every 75 seconds, a child under the age of 5 years dies of malaria throughout the world. Burkina Faso is ravaged by malaria and has responded to the disease by implementing several strategies including Seasonal Malaria Chemoprevention (SMC). In order to make available baseline data for the study on the efficacy of supervised 3 doses SMC distribution, this study was intended to identify malaria-associated factors in children from 0 to 59 months old in the two health districts. **Methods**: This is an analytical cross-sectional study, a first step of a quasi-experimental study that was conducted in Boromo and Gaoua. Data were collected outside of SMC campaigns. A logistic regression calculated the odds ratios with a level of α= 0.05. **Results**: Age groups of 11-23 months (aOR =2.08, 95% CI = [2.02- 2.38]), 24-59 months (aOR= 2.28, 95% CI = (2.11-2.71), P<0.0001); past history of fever (aOR=92.43 95% CI = (37.98-224.92)), p<0.0001; ≥5km distance from village to healthcare center (aOR=4.71, 95% CI = (1.43, 15.45] , p=0.01), sleeping under a long-lasting insecticide-treated net during the last night (aOR= 0.49, 95% CI =[0.28-0.69], P=<0.0001) were associated with malaria. **Conclusion**: Several strategies to respond better to malaria should be implemented in these two districts in order to eliminate malaria. These should target the parents of children whose age is at least one year, living far from healthcare centers, and focus on the use of insecticide-treated nets and the need to send every child with a fever to a healthcare centre.

Introduction

Malaria has persisted as a major global public health concern for over a century, affecting approximately 40% of the world's population and representing the primary parasitic endemic disease worldwide [1]. It is caused by the Plasmodium genus protozoan and transmitted through infected female Anopheles mosquitoes, predominantly in tropical and subtropical regions [2]. Despite being preventable and treatable, malaria continues to cause substantial morbidity and mortality, with pregnant women and children under the age of 5 bearing the greatest burden [3]. Sub-Saharan Africa is particularly affected, with 95% of cases occurring in this region and children under 5 accounting for the majority of cases and deaths [4].

In Burkina Faso, malaria is a leading cause of medical consultations and mortality, especially among children under 5, prompting the implementation of interventions aligned with WHO guidelines, such as seasonal malaria chemoprevention (SMC) [5]. SMC is defined by WHO as "intermittent administration of full treatment courses of an antimalarial medicine during the malaria season to prevent malarial illness with the objective of maintaining therapeutic antimalarial drug concentrations in the blood throughout the period of greatest malarial risk"[6]. In Burkina Faso, SMC is administered during the four months of the rainy season, the peak transmission season, from July to October. Each month, three daily doses of antimalarial medication are administered to children aged 3 to 59 months.

Community health workers (CHWs) are trained to administer the first dose in Directly Observed Treatment (DOT). The other two doses are given to the parents/guardians of the children who are responsible for administering them to the child on the following two days. This strategy is called 1DOT. However, varying effectiveness of SMC campaigns has led to the introduction of enhanced strategies like the 3 Directly Observed Treatment (3DOT) in certain districts [7]. The 3DOT involves supervised administration of the three daily doses of SMC by CHWs. Our study aimed to identify factors associated with malaria among children under 5 years in Boromo and Gaoua districts, providing crucial data for evaluating the efficacy of the 3DOT strategy and informing advocacy efforts for optimal malaria elimination by 2030, in line with the National Malaria Control Program's strategic plan.

Methods

Study setting

Located in the Boucle-du-Mouhoun region of Burkina Faso, Boromo covers an area of 4 539km². In 2020, its population was estimated at 313,839 inhabitants of which 18.78% were children under 5 years and 64.4%were rural. The district records an abundant annual rainfall of 935 mm and malaria transmission is hyper-endemic, with 39.92% of consultations in 2020. Children under five accounted for 42.18% of malaria cases and 70.58% of malaria deaths in the district. [8]. SMC was launched in Burkina Faso in 2014 and has been implemented in Dedougou, a neighbouring district of Boromo. There was one medical centre, 38 centres for health and social promotion (CHSP), and a medical centre with a surgical unit in the district in 2020, with 53,472 target children for SMC [8]. In the district of Boromo, SMC distribution uses the 1DOT strategy, which involves the supervision of the first dose of medication by a community agent and the administration of the remaining two pills by the child's guardian over the following 2 days.

The health district of Gaoua is located in the southwest region with a surface area of 5 098 km2. Its population was 275.274 inhabitants in 2020 with 17.2% of children below five years of age. In 2020 there were 4 949 health visits for malaria in the southwest region and 935 visits in the district of Gaoua. Children under 5 represented 42.18% of malaria cases and 70.58% of deaths due to malaria. In addition to its regional hospital, the district had one medical center, 31 centers for health and social promotion [8]. The type of climate is south soudanian and the region receives the highest rainfalls with an annual pluviometry of 1205 mm. The district of Gaoua was the first district of the south west region to have the seasonal malaria chemoprophylaxis implemented on February 12th 2015. The 1DOT strategy was carried out until 2020 when the 3 Directly Observed Treatment (3DOT) strategy was implemented in a few districts including the district of Gaoua. The targeted children for the SMC was 45 958 in 2020 [8].

Study design

We conducted an analytical cross-sectional study, a first step of a quasi-experimental study from

December 9th -24th, 2020, focusing on children aged 3 to 59 months living in the districts of Boromo and Gaoua.

Sample size estimation and Sampling

The study aimed to provide basic data for assessing the effectiveness of the 3-dose supervision strategy of the SMC. It utilized cluster randomization, with the center for health and social promotion (CHSP) as the unit of randomization, based on the smallest health area. We estimated the required number of clusters and person-months in each group using Hayes' randomized controlled trials size calculation method [9]. Based on data from the District Health Information Software 2015 (DHIS2), the overall estimated incidence rate for all 15 health facilities which implemented SMC was 24 cases per 100 person-months; this corresponded to the incidence rate in the 1DOT group in our hypothesis (Table 1). We considered different hypotheses of relative reduction in incidence rate and performed a sample size calculation. Hypothesis 2 was chosen due to budget constraints, representing at least 1980 children to be included in at least 6 clusters, with an additional 10% increase for non-responses. Proportionally, 0.56% (3.33 CHSP) of participants were drawn from Boromo and 0.44% (2.67 CHSP) from Gaoua. Seven health facilities were randomly selected from the health districts of Boromo and Gaoua to receive either the 3DOTs or 1DOT strategy. All children in the chosen CHSPs were included in the study. The CHSPs of Niampira, Tako, and Dapola were selected in Gaoua, and the CHSPs of Koikoi, Madou, Ourobounou, and Yona in Boromo, representing 924 children in Gaoua and 1516 children in Boromo, resulting in a total sample size of 2440 children.

Data collection

Interviews were conducted as well as a document review (health booklet, free care forms, ambulatory visit registers and CPS registers) and observations to collect data in a form. A total of 14 interviewers, comprising seven CSPS community agents and seven medical students, carried out the survey, under the supervision of investigators and students of master in field epidemiology. The community agents acted as guides and translators for parents/guardians when they did not understand the language spoken by the interviewer. The interviewer administered the form to the children's parents/guardians during a face-to-face meeting. They collected the socio-demographic data of the children and their parents, as well as the children's clinical data and the children's guardians' knowledge of preventive measures against malaria. Any information missing at the end of the meeting was completed using the health documents listed above. The information was also confirmed using the same documents. The presence of fever within the last 72 hours was verified and the diagnostic through rapid diagnostic test (RDT) was performed on children who were not yet diagnosed with malaria.

The parents were encouraged to seek help with a community-based agent or go to a health center whenever the child had fever. The children suffering from malaria or fever of another origin were sent to a health center to be treated. Otherwise, the treatment was conducted according to the integrated management of childhood illnesses (IMCI) for the children below five years of age for two diseases or more, namely diarrhea, pneumonia, malaria, severe malnutrition diagnosed at a community level (by community-based health agents).

Operational definitions

Confirmed case of malaria: Patient suspected to have malaria with a positive diagnostic test (RDT, Microscopy) + patients suspected to have malaria without performing a diagnostic test [10].

Fever: is defined as an axillary temperature ≥ 38° Celsius; the history of fever in the last 72 hours is summarized in the sensation of high temperature in the last 72 hours that was reported by the parents/tutors during the survey.

"Sleeping under a long-lasting insecticidal nets (LLIN) during the last night": interviewers had to ask the guardian/parent whether the child had spent the previous night in the household surveyed, and whether he or she had slept under an insecticide-treated mosquito net. If the answer was yes, the interviewer had to check that the net was hung up before agreeing with the "Yes".

Potential confounding factors were included in the analysis to better measure associations independent of malaria. These were the level of education of tutors. In fact, the tutor is responsible for the child's daily routine and all the malaria-prevention measures he needs to take. The tutor was the child's guardian. This is the person with whom the child lives; they exercise parental authority over the child. This person is responsible for the child's protection, health, education, and for providing for their daily needs. Two modalities were selected: the "schooled" level for tutors who have been to school and can read and speak French; "unschooled" otherwise.

Data analysis

We described the socio-demographic features of the population; qualitative variables were expressed in proportions and ratios (95% confidence intervals [95% CI]). Subsequently, for etiological analysis, a univariate logistic regression was initially conducted to calculate the crude Odds Ratio (cOR) for the association between different factors and malaria. The significance of these ORs was tested using the Wald test, and 95% confidence intervals (CI) were estimated. Variables with a P-value <20% in the univariate analysis, along with relevant confounding factors identified in the literature, were included in a multivariate logistic regression to determine factors independently associated with malaria. Adjusted ORs (aORs) and their 95% confidence intervals were estimated. A significance threshold of $\alpha = 0.05$ was used for interpreting the variables. Analysis was performed with the statistical software Epi-Info version 7.2.2.6.

Ethical considerations

The study protocol was approved by the reference No 2016-9-103 by the national ethic committee of the Ministry of health and public hygiene of Burkina Faso prior to the survey. This approval was shared with the regional directors of the south-west and the Mouhoun buckle and then transmitted through the health pyramid to the doctors in charge of the health districts of Boromo and Gaoua, the nurses in charge of the selected centers, the community-based health workers, as well as the local authorities. informed consent was obtained from the children's representatives. During a home visit, the investigators, consisting of a pair with a medical student and a community health worker (serving as an interpreter if necessary), introduced the study with the information leaflet and consent form. The child's parent/guardian could ask questions about the study before giving consent. If the parent/guardian was illiterate, they were assisted by an impartial witness. If consent was given, the parent and the investigator dated and signed the consent form.

Results

Socio-demographic features of children of the study

We included a total of 2440 children in the study. All parents gave informed consent before the data collection interviews began. The children from age 2 to 5 were the most represented (64.22%); $p< 0.0001$; they consisted of 1233 male (50.97%; p=0.5) with a male/female sex ratio of 1.03. Among the 2240 children who were surveyed, 2048 (84%; p<0.0001) of them had bed nets; 207 children developed fever within 72 hours (8.66%; p<0.0001). Among guardians of children, females predominated (89.58%) with a f:m sex ratio of 0.11 ($p = 0.028$). There were 91.10% (p=0.01) unschooled tutors. Mothers were the most represented group with 1512 (64.07%, p=0.04) (Table 2).

Factors associated with malaria in children from 3 to 59 months old in the health districts of Boromo and Gaoua in 2020 on a multivariate analysis

The sociodemographic and clinical factors associated with malaria in univariate analysis, just as reported in table 3, were: the child belonging to Gaoua district [cOR=1.87 ; 95% CI (1.29, 2.7) ; p =0.00]; the age of the child between 12-23 months [cOR=2.21 95% CI (2.31, 2.45); p <0.0001]; and 24-59 months [cOR=2.31 95% CI (2.31, 2,78); p<0.0001]; ≥5km distance between the health facility and the villages [cOR=4.36; 95% CI (2.59, 7.35) p<0.0001]. As for clinical data, the past history of fever was the only factor associated with malaria [cOR=61.37; 95% CI_9 (38.17-98.67),p=0.0001].

Gender of the respondent [cOR=0.37 95% CI (0.15-0.93) ; p=0.03], having a LLIN [cOR=0.50 95% CI (0.32- 0.77) ;p<0.0001], sleeping under a LLIN during the last night [cOR=0.39 95% CI (0.26 – 0.58); p<0.0001], knowledge on malaria symptoms [cOR=0.50 95% CI (0.29 – 0.85); p= 0.01] were also associated with malaria in univariate analysis (Table 3). After univariate analysis, the variables that had a p-value lower or equal to 0.20 were selected for the multivariate analysis.

In multivariate analysis, the factors associated with malaria were: age (12-23 months), (24-59 months) with respectively [aOR=2.08, 95%CI = (2.02-2.38)] and [aOR= 2.28, 95% CI = (2.11-2.71)]; past history of fever [aOR=92.43, 95% CI= (37.98-224.92)]; ≥5km distance between the health facility and the villages [aOR=4.71, 95% CI = (1.43, 15.45)] and sleeping under a LLIN during the last night [aOR= 0.49, 95% CI =(0.28-.69)] (Table 4).

Discussion

Our study identified children between the ages of 12-59 months, a history of fever, 5+km distance from health centres, and not sleeping under an insecticide-treated net as factors associated with malaria among children under five in Boromo and Gaoua districts in December 2020.

Compared with the 3 months to 11 months age group, the age group of 12 to 23 months, and 24 to 59 months were associated with malaria with a small dose-response relationship, i.e. ORs of 2.21 and 2.31 respectively. In fact, these age ranges are less protected against malaria as compared to the age range from 3 months to 11 months. This could be due to the fact that the latter group still benefit from the immunity/premunition of the mother. However, the vulnerability of the age group between 12 and 23 months could be explained by their physiological state which is characterized by a "decline in maternal immune protection from the mother by 6 months of age, making the child unable to fight against malaria. The child immunity will grow progressively over the years due to the multiple malaria infections that occur. Our results are similar to those of other authors in Africa such as Danielle Robert and his colleagues in Uganda 2016 that reported an association between malaria and children above 24 months of age with a statistical significance (OR = 1.02 CI at 95 % = 1.023 -1.033; P=0.02) [11]. In a similar way Chigozie Louisa and his colleagues in Nigeria 2020 and Gountante Kombate and his colleagues in Togo 2022 reported that the number of malaria infections grew with age, respectively in children 49 to 59 months (OR = 4.680, CI at 95 % = 3.674 – 5.961 ; P<0.0001) and those aged 24 to 59 months (OR = 1.46, CI at 95 % [1.13-1.88]) [12,13]. In fact, the age group of 24 months and above correspond to the period of stopping breastfeeding and adapting the child alimentation to its growth needs. The nutritional deficiencies could explain the high risk for developing the disease.

Our study reported sleeping under a LLIN during the last night as a protective factor against malaria compared to those who had not. The use of LLIN remains one of the best ways to fight against malaria. Sleeping under long lasting insecticide treated nets prevents mosquito bites thus protecting the child against malaria. In fact, the use of LLIN allowed the protection of millions of children against malaria during the period of high transmission which is the rainy season [5,]. Our results are similar to those reported by Coulibaly in Ivory Coast, 2016, Abdelsalam Adoum Doutoum in Tchad, 2019 and Mukomena in the Democratic Republic of Congo, 2016 which showed that the use of LLIN reduced the risk of contracting malaria with the following respective p values : p = 0.018 ; p<0.001 ; p = 0.0027 [14–16]. The national malaria control program should intensify the distribution of insecticide-treated nets through mass campaigns. But it turns out that, despite costly campaigns to distribute LLINs every 3 years or so, malaria is still rife in these areas. This raises the question of the need to review vector control. Indeed, the hydro-agricultural development of these areas, the lack or poor sanitation and the type of habitat offer favorable conditions for the proliferation of malaria vector larval breeding sites and contribute to the transmission dynamics of Plasmodium. Added to this is the resistance of the malaria vector to the various insecticides described since 2013 in Burkina[17], partly explained by the anarchic use of pesticides in agriculture, resulting in the reduced effectiveness of LLINs. In other words, the combination of concomitant multi-sectoral efforts is essential if malaria is to be eradicated.

However Félix Essiben in Cameroon 2016 did not find a significant association between the use of LLIN and malaria (failure of intermittent preventive treatment of malaria with sulfadoxine-pyrimethamine resulting in malaria) in their multivariate analysis (OR= 1.81; CI= 0.95 – 3.47 ; P=0.071) [18]. This difference could be explained by the fact that the two population of study, the sample size and the type of study were not identical; our study targeted children under five years of age while their study was a case-control one conducted on 234 pregnant women. As reported Bisong [19], a number of pregnant women do not use LLIN, stating several reasons including high temperatures, feeling of being in prison. Furthermore, given this non-significant association (OR = 1.81) (p = 0.071), it could be that this case-control study which included 234 subjects including 109 cases and 125 controls could have lacked power to highlight a significant association between the non-use of LLINs and malaria; but details on the calculation of the sample size are not given.

It is clear from the above that not only do countries and partners need to maintain or step up LLIN distribution campaigns, they also need to find ways of encouraging people to use these means of protection, and to combine them with simple measures to eradicate breeding sites. Fever was strongly associated with malaria, children with fever in the last 72 hours were 92.43 times more likely to develop malaria than those without fever. Although malaria has several symptoms, fever that occurs after the burst of infested red blood cells is frequent in the majority of cases. These results are similar to those of Emmanuel A Temu in Mozambique 2012 and those of Humphrey R Mkali in Zanzibar 2021 which reported, but with less associative force, that the past history of fever increased the risk of developing malaria (OR = 1.2; CI [1.02- 1.5]) and(OR = 35.7; CI [32.3- 39.5]) [20,21]. His result suggests that there is a subgroup of the population that does not show up in health centres when they develop malaria symptoms such as fever. Therefore, it remains necessary to send out messages that could help recognize malaria symptoms and would persuade people to seek care in health centers.

However, it contrasts with the low prevalence of 22.1% (District Arba Minch Zuria) and of 18.7% (health center Kolla-Shele) of malaria cases within the cases of fever around kebele [22]. The authors had suggested that the low prevalence was due to the fact that the study was conducted at a time of low transmission of malaria.

The children who lived in homes that were more than 5 km away from a health center had a 4.71 greater more chance of developing malaria as compared to other children. The inaccessibility of healthcare systems could be the cause of high prevalence of malaria. The financial barrier (high transportation costs or insufficient human resources) and the geographic barrier (lack of health center in the area or inaccessibility of the health center due to security concerns linked to terrorism and impracticable roads) are a number of factors that could increase the risk of malaria infection in a community. Our results are similar to those of Diallo in Guinea in 2021 reporting that living far away from healthcare facilities was associated with malaria with a significant difference (P = 0.001) [23]. In the same way, Shino Arikawa in Togo, 2023 reported that living beyond 5 km from a healthcare facility was associated with malaria with an OR = 1.60; 95%CI[1.04-2.44] ; P = 0.01 [24] . The occurrence of malaria could be explained by difficult access to healthcare facilities, and information, but also could be due to the consequences of environmental risk factors such as the use of agricultural fields, the presence of animals, the proximity to reproduction sites, and the quality of housing. However, the results suggest that more common efforts are required to address the vulnerability of children living in remote zones which are difficult to access.

Limitations

Our study had three main limitations. Firstly, past fever history relied solely on parental/legal guardian reports, potentially introducing classification bias, especially in children with no or low fever, though this bias is non-differential across districts. Even if differential, this bias may have led to a loss of power, reducing the OR estimate to 1. Community communication on fever and the need to consult the health center in the event of fever, or even the provision of thermometers to guardians of children under 5 at the time of the census, could be used in future studies to avoid this bias. Secondly, malaria classification might be biased as it relied on child health booklets or drug prescriptions, potentially underestimating prevalence, particularly for children without health center visits, who might be misclassified if they did not undergo rapid diagnostic tests. Lastly, our study coincided with the harvest season, posing challenges in data collection due to families traveling for work, potentially leading to missed children. The nutritional status known to be a factor associated with malaria could not be collected. The food program implemented in these regions of the country by the government and its partners, namely the administration of a single input for the prevention and treatment of acutely malnourished children, mobile clinics, integrated community management of acute malnutrition, and the use of the advanced strategy, led us not to collect this variable. Since socio-economic status had been identified as a factor associated with malaria, it was taken into account in our data collection through the "Tutor's occupation" variable. However, it was not possible to adjust for this factor, as 98.4% of the children's guardians in these selected villages had replied that they were farmers. All these biases tend to underestimate the existence of malaria, so children with malaria may have been classified as not sick; this could have led to an underestimation of the association ORs. However, the results can be generalized to most of the country, and even to other countries implementing chemoprevention of seasonal malaria, as these areas are predominantly rural, and live from fieldwork, and therefore from the same realities. In addition, children and/or their families move in and out of the study areas, which may or may not have shifted the ORs in one direction or the other.

Conclusion

This study identified factors associated to malaria including the age range from 12 to 59 months, distance to health facilities beyond 5 km, past history of fever, and the use of long-lasting insecticide-treated nets (LLINs). Effective malaria control necessitates promoting and implementing WHO recommendations on LLIN distribution, emphasizing proper LLIN use through sensitization, and recognizing health centers as primary care facilities. Increasing the number of health facilities, particularly in areas with a low concentration of health facilities, could improve access to healthcare. A combination of different strategies is essential to aim for malaria elimination by 2035, as outlined in the Sustainable Development Goals, requiring a security context in the country that is experiencing terrorism, more voluntary and more committed political and community participation.

What is already known about the topic

- Malaria remains a significant global public health issue, particularly affecting children under 5 and pregnant women, with Sub-Saharan Africa bearing the highest burden.
- Despite being preventable and treatable, malaria continues to cause substantial morbidity and mortality, necessitating various control strategies, including the implementation of Seasonal Malaria Chemoprevention in affected regions.
- In Burkina Faso, malaria is a leading cause of medical consultations and mortality among children under 5, prompting the adoption of enhanced strategies such as the 3 Directly Observed Treatment (3DOT) to improve the effectiveness of existing SMC campaigns.

What this study adds

- This study identifies factors associated with malaria in two districts before the implementation of seasonal malaria chemoprevention
- These results are consistent with those encountered in the region.
- These results will allow comparison with the factors that will remain associated with the disease after the implementation of the same intervention, in the innovative strategy of 3 directly observed treatments (3DOT) as in the strategy of traditional seasonal malaria chemoprevention campaigns in Burkina Faso.

Competing Interest

The authors of this work declare no competing interest

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Authors´ contributions

YPK and YC developed the protocol, collected, analyzed and interpreted the data. YC prepared the initial draft, and YPK, YC and TH reviewed several drafts and provided critical comments. All authors read and approved the final manuscript.

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Table 1: Estimate of the number of subjects required for the comparison of incidence rate between the two groups in the month following the passage of SMC							
Assumption	Expected relative reduction	Incidence rate 1DOT (case in person-months)	Incidence rate 3DOT (case in person-months)	m (Cluster size)	K (the coefficient of variation)	Assumption	Expected number of subjects
1	75%	0.24	0.06	300	0.39	4	1200
2	67%	0.24	0.0792	300	0.39	6	1800
3	50%	0.24	0.12	300	0.39	12	3600
4	34%	0.24	0.1584	300	0.39	30	9000
5	30%	0.24	0.168	300	0.39	36	10800

Table 2: Socio-demographic and clinical features of children from 3 to 59 months old and their tutors in the health districts of Boromo and Gaoua in 2020, Burkina Faso			
Variables	**Number (N = 2440)**	**Percentage**	**P value**
Age			
3 months – 11 months	504	20.67%	< 0.0001
12 months – 23 months	369	15.12%	
24 months – 59 months	1567	64.22%	
Sex			
Male	1233	50.97%	0.53
Female	1186	49.03%	
Possession of a bed net			
Yes	2048	84%	< 0.0001
No	392	16%	
Past history of fever			
Yes	207	8.48%	< 0.0001
No	2184	91.34%	
Children below 5 years of age with a tutor			
1	655	32.95%	0.4
2–5	1288	64.79%	
≥6	45	2.26%	
Persons in the family			
0–5	985	50.10%	0.13
6–10	597	30.37%	
11–20	311	15.82%	
≥21	73	3.71%	
Tutors relation to child			
Legal Guardian	602	25.51%	0.04
Mother	1512	64.07%	
Father	246	10.42%	
Level of education of tutors			
Not schooled	1750	91.10%	0.011
Schooled	171	8.90%	
Gender of tutors			
Male	246	10.42%	0.028
Female	2114	89.58%	
Tutors Marital status			
Single	2255	93.96%	0.14
Married	44	1.80%	
Divorced	145	6.04%	
Age of tutors			
<18 years	36	1.71%	0.48

18–24	400	19.05%	
25–59	1597	76.05%	
≥60	67	3.19%	

Table 3: Sociodemographic and clinical features associated with malaria in children from 3 to 59 months old in the health districts of Boromo and Gaoua in 2020 on a univariate analysis		
Variables	**Crude OR [95% CI]**	**P-Value**
Child Sex		
Girl	1	
Boy	0.81 [0.55–1.18]	0.28
Age of the child		
3 months – 11 months	1	
12 months – 23 months	2.21 [2.31–2.45]	< 0.0001
24 months – 59 months	2.31 [2.31–2.78]	< 0.0001
District		
Boromo	1	
Gaoua	1.87 [1.29–2.72]	< 0.0001
Distance from health center		
< 5 km	1	
≥ 5 km	4.36 [2.59–7.35]	< 0.001
Past history of fever		
No	1	
Yes	61.37 [38.17–98.67]	< 0.0001
Sex of legal guardian		
Woman	1	
Man	0.37 [0.15–0.93]	0.03
Knowledge on malaria symptoms		
No	1	
Yes	0.50 [0.29–0.85]	0.01
Possessing a LLIN		
No	1	
Yes	0.50 [0.32–0.77]	< 0.0001
Sleeping under a LLIN during the last night		
No	1	
Yes	0.39 [0.26–0.58]	< 0.0001

Table 4: Factors associated with malaria in children from 3 to 59 months old in the health districts of Boromo and Gaoua in 2020 on a multivariate analysis

Variables	Adjusted OR (95% CI)	P-Value
Age of child – 3 months – 11 months	1	
Age of child – 12 months – 23 months	2.08 [2.02–2.38]	< 0.0001
Age of child – 24 months – 59 months	2.28 [2.11–2.71]	< 0.0001
LLIN last night – No	1	
LLIN last night – Yes	0.49 [0.28–0.69]	< 0.0001
Past history of fever – No	1	
Past history of fever – Yes	92.43 [37.98–224.92]	< 0.0001
Distance from health center – < 5 km	1	
Distance from health center – ≥ 5 km	4.71 [1.43–15.45]	0.01