Research Article

Journal of Clinical Immunology & Research

Prevalence and risk factors of malaria among children under five years in High and Low altitude rural communities in the Hohoe Municipality of Ghana

Margaret Kweku[1], Wisdom Takramah[1], Wisdom Kudzo Axame[1], Richard Owusu[1], Mohammed Takase[3], Martin Adjuik[1] and Elvis Tarkang[2*]

[1]*Department of Epidemiology, and Biostatistics, School of Public Health, University of Health and Allied Sciences, Ho, Volta Region, Ghana.*

[2]*Department of Population and Behavioral Science, School of Public Health, University of Health and Allied Sciences, Ho, Volta Region, Ghana.*

[3]*School of Biological Sciences, University of Cape Cast, Cape Coast, Central Region, Ghana.*

[*]Correspondance:
Elvis Tarkang, Department of Population and Behavioral Science, School of Public Health, University of Health and Allied Sciences, Ho, Volta Region, Ghana, E-mail: ebeyang1@yahoo.com.

Received: 05 July 2017; **Accepted**: 01 August 2017

Citation: Kweku M, Takramah W, Kudzo Axame W, et al. Prevalence and risk factors of malaria among children under five years in High and Low altitude rural communities in the Hohoe Municipality of Ghana. J Clin Immunol Res. 2017; 1(1): 1-8.

ABSTRACT

Background: *Malaria due to P. falciparum remains one of the most important causes of morbidity and early mortality in endemic regions of sub-Saharan Africa. This study assessed the prevalence of malaria among children less than five years residing in High-Altitude and Low-Altitude rural communities in the Hohoe municipality.*

Methods: *A community-based cross-sectional survey involving children less than five years in four selected rural communities. Information was collected on the background of the children, ownership and use of LLIN and fever. Anthropometric indices and axillary temperature were measured, as well as RDT and blood film for malaria parasites and haemoglobin levels. Proportions were analyzed using Chi-square and Multivariable logistic regression was used to determine the association between dependent and independent variables.*

Results: *A total of 325 children with 174 (53.5%) from Low-Altitude and 151(46.5%) from High-Altitude communities were surveyed. The prevalence of malaria among Low-Altitude and High-Altitude children as indicated by RDT was 56.9% and 19.9% respectively and by microscopy was 41.4% and 3.3% respectively. Ownership and use of LLIN among Low-Altitude and High-Altitude children were high and similar (96.6% vs. 97.4%) and (79.9% vs. 75.5%) respectively. High-Altitude children were 96% less likely to have malaria as compared to Low-Altitude (AOR=0.04, p<0.001). Children aged 24-35, 36-47 and 48-59 months were 6.73, 4.10 and 7.16 times more likely to have malaria as compared to those aged 6-11 months (AOR=6.73, p=0.007), (AOR=4.10, p=0.050) and (AOR=7.16, p=0.007) respectively. Children with mild anaemia and low-Hb (Hb<8.0g/dl) were 2.49 and 4.15 times more likely to have malaria as compared to those with normal haemoglobin concentration (AOR=2.49, p=0.026) and (AOR=4.15, p=0.023) respectively. Those with a history of fever within one week were 4.91 times more likely to have malaria (AOR=1.74, p<0.001) respectively.*

Conclusion: *Malaria prevalence was higher among Low-Altitude than High-Altitude children, despite high LLIN ownership and usage in both areas. Altitude, therefore, has a major effect on malaria prevalence. Age of child, history of fever within one week and anaemia were other factors associated with malaria. Additional control measures are needed to reduce the burden of malaria in Low-Altitude areas in the Hohoe municipality of Ghana.*

Keywords

Malaria prevalence, Low-Altitude, High-Altitude, Community, Children under five, Hohoe Municipality, Ghana.

Background

The World Health Organization (WHO) estimates the burden of malaria to be 198 million cases with 584,000 deaths in the year 2013 being a major cause of poverty and low productivity and vice versa [1]. Despite the fact that decreasing numbers of malaria cases and mortality are recently reported in some endemic regions, most countries in sub-Saharan Africa (SSA) still suffer from an immense burden of malaria mortality. Data indicates that 90% of

global deaths due to malaria occur in Africa, especially among children under five years [1,2].

According to WHO, there have been large reductions in the number of malaria cases and deaths between 2000 and 2015 [3]. The recent health improvement in Africa has resulted from achieving high malaria control intervention coverage, especially with LLINs and targeted IRS, and this has been the leading contributor to reduced child mortality [4].

The Ghana National Malaria Control Programme (NMCP) has increased coverage and usage of available intervention tools over the past decade and indications are that the endemicity levels could be reducing [5]. The Ghana Demographic Health survey (GDHS) reported that in 2014, LLIN ownership and usage in rural areas was 79% and 56.1% respectively. It also found that the prevalence of malaria by RDT in rural areas was 54.6% and by microscopy was 37.7%. Low haemoglobin levels (Hb<8.0g/dl) in rural areas was 12.0% [6].

In spite of the increased coverage and usage of LLIN, reports still indicate that malaria tops most OPD cases and kills 3 children every day in Ghana [7]. Similarly, in the Hohoe municipality, malaria is still the leading cause of OPD attendance (28%) and the leading cause of deaths (19.4%) [8].

This current study was a health assessment survey conducted at selected sentinel sites to determine the prevalence of malaria parasitaemia and anaemia among children residing in Low-Altitude (L-A) and High-Altitude (H-A). It also determined the factors associated with malaria prevalence. Information gathered would serve as a baseline before the start of the surveillance activities in these communities.

Materials and Methods

Study Area

The study was undertaken in Hohoe Municipality, which is one of the twenty-five administrative districts in the Volta Region of Ghana.

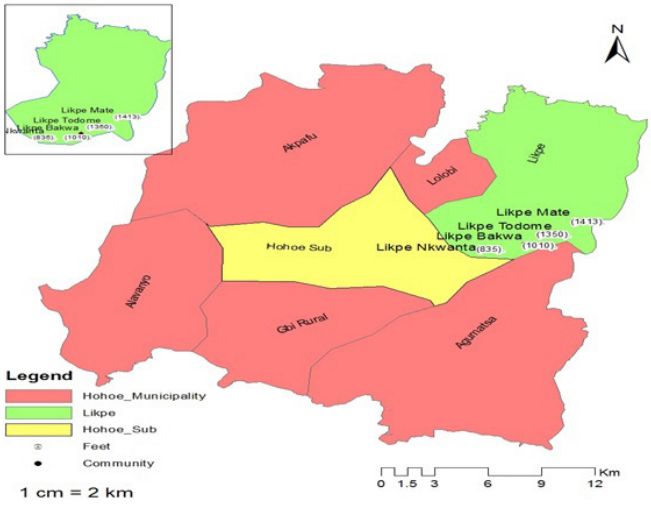

Figure 1: A Hohoe map showing the study site.

The Municipality is located in the central part of Volta region, with a population of 167,016 inhabitants. Hohoe, the Municipal capital has a population of 63,000 inhabitants [9]. The Municipality has two main seasons: the wet and dry. The major wet season is from April to July and the minor one is from September to November. The rest of the year is relatively dry. According to the Hohoe Municipal Meteorological Department (HMMD), temperatures in the municipality vary between 22˚C and 37˚C with an average annual rainfall of 1,592 mm. Malaria transmission occurs throughout the year with seasonal peaks, coinciding with the period of the rains (high malaria transmission begins in June and ends in November).

Study Design

The design was a cross-sectional study carried out in November 2015 (the end of the high transmission season). Data was collected in the form of interviews and collection of biological samples. The population for the study was all children in the selected communities aged 6 to 59 months who were eligible and their parents/guardians consented to participate.

Sampling and sample size determination

Purposive sampling technique was used to select four communities because those were the communities identified by the School of Public Health (SPH) of the University of Health and Allied Sciences (UHAS).

The sample size was estimated on the basis of the following: 95% confidence level (Z) and power of 80%, the prevalence (P) of malaria in children aged less than 5 years in November 2010 (end of rainy season) as 33.3% [10]. The least acceptable prevalence of malaria was 5.0%. Using Open Epi software version 3, the sample size calculated for the cross-sectional surveys was 305 children aged less than 5 years (Fleiss Statistical Methods with Continuity correction). However, all children whose parents/guardians reported for the survey, consented and were willing to participate were included. Therefore, a total 325 were included in the survey.

Data Collection

Data collection involved asking parents/guardians of the children questions and collecting finger prick blood from the children for laboratory investigations. During the survey, all eligible children were gathered at an agreed common meeting place and temperature, weight, height and mid-upper-arm circumference were measured. A finger prick blood sample was collected for determination of malaria parasitaemia and haemoglobin (Hb) levels. Information was also obtained on LLIN ownership and usage.

Laboratory Methods

Malaria Blood Films for Microscopy

Thick blood films were prepared on a glass slide using 10 µL of blood, evenly spread to cover an area of 15 x 15 mm of the slide. The smear was stained with 10% Giemsa for 10 minutes and then examined under oil immersion with a light microscope (magnification x 100). The slides were double read by trained Microscopists. Asexual parasite densities were estimated by

counting the number of parasites per 200 white blood cells (WBCs) in the thick film. Parasite counts were converted to parasites per microliter (µl), using relative WBC of 8000 leukocytes per µl of blood.

Similarly, gametocyte rate and density were determined by counting against 500 leukocytes and converted to parasites per microliter as for asexual parasites [11]. A sample was considered negative if no parasite was counted after 200 high power fields had been read. If there occurred discrepancies in the findings in a slide between the two initial technicians (positive or negative or a 50% or more difference in parasite density) a third, more senior microscopist reading was deemed necessary and then adopted. Two senior Microscopists from the Noguchi Memorial Institute of Medical Research (NMIMR) and University of Health and Allied Science (UHAS), examined all the positive blood films including a 20% random sample of negative blood slides for quality control.

Haemoglobin and fever measurement

Haemoglobin was measured using URIT-12 Hemoglobin Meter (URIT Medical Electronic Co, Ltd. UK) whilst fever was measured using an electronic thermometer (MODE: ZC, SURGILAC Digital Thermometer, UK).

Rapid Diagnostic Testing of Malaria in Human Blood

CareStart™ Malaria HRP2 test kit (Access Bio Inc, New Jersey, USA) was used for the rapid qualitative detection of Malaria Histidine-rich Protein 2 (HRP2) in human blood as an aid in the diagnosis of malaria infection. Using this kit, 5 µL of whole blood was introduced into the sample well with the aid of a pipette after finger pricking. Three drops of assay buffer were added to the buffer well. The result was read within 20 minutes.

Anthropometric Measurement

Children under one year were weighed naked while older children above one year were weighed with their pants on Seca weighing scales (Hamburg, Germany) to the nearest 10 grams. The length of children aged less than 24 months were measured using non-stretchable tape to the nearest mm and a locally made measuring board precise to 1 mm.

Children aged 24 months or more had their height measured while standing using a locally made measuring board precise to 1 mm. Mid-Upper Arm Circumference (MUAC) was measured on the left arm to the nearest 1 mm using a non-stretchable tape.

Definitions

High-Altitude: Communities located on land with elevation >10,000ft above sea level.
Low-Altitude: Communities located on land elevation ≤10,000ft above sea level.
Fever: was defined as axillary temperature ≥ 37.5%ºC.
Low Haemoglobin (low Hb): defined as an Hb<8.0 g/dl.
Mild anaemia: Defined as Hb≥8.0<11.0g/dl.
Normal Haemoglobin level: defined as Hb≥11.0gm/dl.

Data Analysis

Data was entered using EPI DATA 3.1 software and then exported to STATA 14 (Stata Corporation, Texas, USA) for analysis. After data was entered, cleaning and validation was done to ensure data quality before analysis was carried out. Descriptive statistics such as proportions and frequency distribution were performed to describe categorical variables and the results were presented in bar charts and tables. Inferential statistics such as Chi-square test and logistic regression were used to assess the associations between the categorical dependent and independent variables. P-value <0.05 was considered as statistically significant.

Ethical Issues

The study was approved by the Ethical Review Committee (ERC) of the Ministry of Health/Ghana Health Service, (MOH /GHS), ID NO: GHS-ERC: 14/05/15. Before the commencement of the study, permission was sought from the Municipal Health Management Team (MHMT) and the Municipal administration. Permission was also sought from the chiefs and elders in the selected communities. A written informed consent was obtained from the parents/guardians of the children. All the information collected was treated confidentially and used for research purposes only.

Results

Three hundred and twenty-five (325) children aged 6 to 59 months were surveyed in four rural communities with 174 (53.5%) from L-A and 151 (46.5%) from H-A communities. The overall mean age of the children was (31.3±16.1) (Table 1). The mean weight and height among children were (11.6 ± 2.7) and (84.1 ± 13.1) respectively. More than half 169 (52.0%) of the children were females with 91 (52.3%) from L-A and 78 (51.7%) from H-A. A total 156 (48.0%) were males of which 83 (47.7%) were from L-A and 73 (48.3%) were from H-A.

Children aged between 6-11 months were 48 (14.8%) with 23 (13.2%) from L-A and 25 (16.6%) from H-A. Those aged between 12-23 months 70 (21.5%) with 35 (20.1%) from L-A and 35 (23.2%) from H-A area. Children aged between 24-35 months were 77 (23.7%) with 41 (23.6%) from L-A and 36 (23.8%) from H-A. Those aged between 36-47months 62 (19.1%) with 34 (19.5%) from L-A and 28 (18.5%) from H-A and children aged between 48-59 months were 68 (20.9%) with 41 (23.6%) from L-A and 27 (17.9%) from H-A.

Approximately 6 (1.9%) were severely malnourished with 4 (2.3%) from L-A and 2 (1.3%) were from H-A. Children who were moderately malnourished11 (3.4%) with 3 (1.7%) from L-A and 8 (5.3%) from H-A.

Ownership of LLIN was 315 (96.9%) with 168 (96.6%) from L-A and 147 (97.4%) from H-A. Usage of LLIN was 253 (77.9%) with 139 (79.9%) from L-A and 114 (75.5%) from H-A.

Overall mean age of parents/guardians was 30.1 ± 8.8 years. The majority of parents/guardians of the children were aged less than 30 years 198 (60.9%) followed by those aged 31-40

years 94 (28.9%). parents/guardians aged between 41-50, 51.60 and 60 years and above were 26 (8.0%), 2 (0.6%) and 5 (1.5%) respectively. Majority 176 (54.3%) of parents/guardians of the children attained JHS educational level with 96 (55.5%) from L-A and 80 (53.0%) from H-A. Parents/guardians who attained SHS level of education were 63 (19.4) with 23 (13.2%) from L-A and 41 (27.2%) from H-A. Primary school education was 58 (17.9) with 38 (22.0%) from L-A and 20 (13.3%) from H-A. Those with no formal education were 27 (8.3%) with 17 (9.8%) were from L-A and 10 (6.6%) from H-A. Occupation of most parents/guardians was trading 87 (26.8%) with 44 (25.3%) from L-A and 43 (28.5%) from H-A. This is followed by farming 83 (25.5%) with 62 (35.6%) from L-A and 21 (13.9%) from H-A. Artisanship was 80 (24.6%) with 41 (23.6%) from L-A and 39 (25.8%) from H-A. Those who were unemployed were 68 (20.9%) with 27 (15.5%) from L-A and 41 (27.2%) from H-A and teaching was only 7 (2.2%) with none from L-A and 7 (7.6%) from H-A.

Characteristics	Low-Altitude n (%)	High-Altitude n (%)	Total N (%)	Chi 2 (χ^2)	p-value
Number screened	174 (53.5)	151 (46.5)	325 (100.0)		
Sex					
Male	83 (47.7)	73 (48.3)	156 (48.0)		
Female	91 (52.3)	78 (51.7)	169 (52.0)	0.01	0.908
Mean age (in months) (SD)	33.0 (16.2)	29.4 (15.7)	31.3 (16.1)		
Age group					
6-11	23 (13.2)	25 (16.6)	48 (14.8)		
12-23	35 (20.1)	35 (23.2)	70 (21.5)		
24-35	41 (23.6)	36 (23.8)	77 (23.7)		
36-47	34 (19.5)	28 (18.5)	62 (19.1)		
48-59	41 (23.6)	27 (17.9)	68 (20.9)	2.25	0.689
Mid-Upper Arm Circumference (MUAC)					
Severe malnutrition	4 (2.3)	2 (1.3)	6 (1.9)		
Moderate malnutrition	3 (1.7)	8 (5.3)	11 (3.4)		
Normal	167 (96.0)	141 (93.4)	308 (94.8)	3.52	0.172
Own LLIN					
No	6 (3.5)	4 (2.7)	10 (3.1)		
Yes	168 (96.6)	147 (97.4)	315 (96.9)	0.17	0.677
Used LLIN last night					
No	35 (20.1)	37 (24.5)	72 (22.2)		
Yes	139 (79.9)	114 (75.5)	253 (77.9)	0.90	0.342
Malaria parasitaemia by RDT					
Parasite absent	75 (43.1)	121 (80.1)	196 (60.3)		
Parasite present	99 (56.9)	30 (19.9)	129 (39.7)	46.31	<0.001
Malaria parasitaemia by microscopy					
Parasite absent	102 (58.6)	146 (96.7)	248 (76.3)		
Parasite present	72 (41.4)	5 (3.3)	77 (23.7)	64.8	<0.001
Fever (Temp≥ 37.5ºC)					
No	171 (98.3)	150 (99.3)	321 (98.8)		
Yes	3 (1.7)	1 (0.7)	4 (1.2)	0.75	0.387
History of Fever within one week					
No	116 (66.7)	118 (78.2)	234 (72.0)		
Yes	58 (33.3)	33 (21.9)	91 (28.0)	5.28	0.022
Haemoglobin level					
Normal (Hb≥11.0)	58 (33.3)	49 (32.5)	107 (32.9)		
Mild anaemia (Hb=8.0-10.9)	100 (57.5)	90 (58.6)	190 (58.5)		
Low-Hb (Hb<8.0 g/dl	16 (9.2)	12 (8.0)	28 (8.6)	0.23	0.892
Characteristics of parent/guardian					
Mean age (in years) (SD)	29.5 (9.5)	30.8 (8.0)	30.1 (8.8)		
Age group (in years)					
<30	118 (67.8)	80 (53.0)	198 (60.9)		
31-40	38 (21.8)	56 (37.1)	94 (28.9)		
41-50	12 (6.9)	14 (9.3)	26 (8.0)		
51 and above 60	6 (3.45)	1 (0.66)	7 (2.15)	12.90	0.005
Educational level					
None	17 (9.8)	10 (6.6)	27 (8.3)		
Primary	38 (22.0)	20 (13.3)	58 (17.9)		
JHS	96 (55.5)	80 (53.0)	176 (54.3)		
SHS	23 (13.2)	41 (27.2)	63 (19.4)	13.15	0.004
Occupation of parents/guardians					
Unemployed	27 (15.5)	41 (27.2)	68 (20.9)		
Artisan	41 (23.6)	39 (25.8)	80 (24.6)		
Farming	62 (35.6)	21 (13.9)	83 (25.5)		
Trading	44 (25.3)	43 (28.5)	87 (26.8)		
Teaching	0 (0.0)	7 (7.6)	7 (2.2)	28.71	0.000

Table 1: Background characteristics of children and parents/guardians and association with malaria prevalence.

Ownership and usage of LLINs

Overall, 315 (96.9%) of children own an LLIN out of which 168 (96.6%) were from L-A and 147 (97.4%) were from H-A. Usage of LLIN was 253 (77.9%) with 139 (79.9%) from L-A and 114 (75.5%) from H-A (Table 1).

Prevalence of malaria, fever and anaemia and malnutrition and antimalarial drugs

Table 1 shows that overall, malaria prevalence by RDT was 129 (39.7%) with 99 (56.9%) among L-A and 30 (19.9%) among H-A children (Figure 2). Malaria prevalence by microscopy was 77 (23.7%) with 72 (41.4%) among children from L-A and 5 (3.3%) among H-A children (Figure 3). Fever prevalence was 4 (1.2%) with 3 (1.7%) among L-A and 1 (0.7%) among H-A children. Prevalence of a history of fever was 91 (28.0%) with 58 (33.3%) among L-A and 33 (21.9%) among H-A children. Overall, malnutrition was 6 (1.9%) with 4 (2.3%) among L-A and 2 (1.3%) among H-A children. Moderate malnutrition was 11 (3.4%) with 3 (1.7%) among L-A and 8 (5.3%) among H-A children.

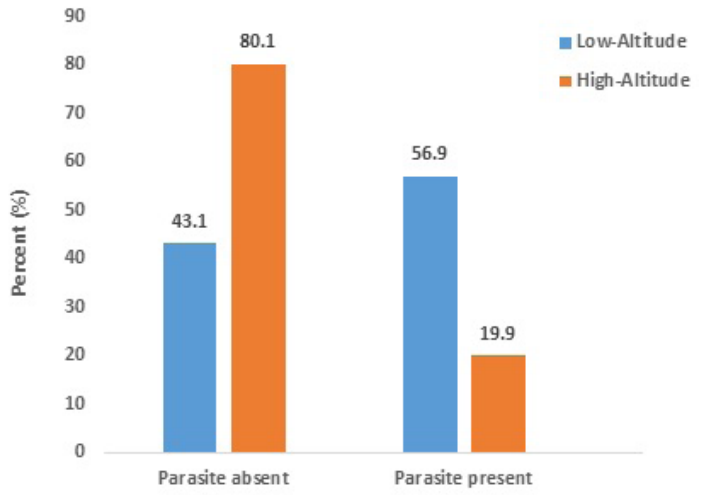

Figure 2: Malaria parasites prevalence by RDT.

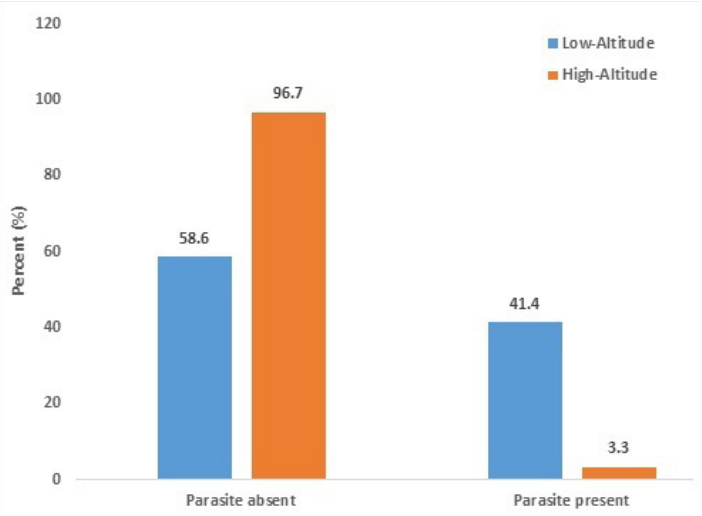

Figure 3: Malaria parasite prevalence by microscopy.

Association between Background Characteristics of Children and their parents/guardians and malaria prevalence

Table 1 shows that there was no significant association between gender, the age of child and malaria infection (χ^2=0.01, p=0.908, α=0.05) and (χ^2=2.25, p=0.689, α=0.05). There was also no significant association between community size and malaria prevalence (χ^2=0.00, p=0.999, α=0.05). There was however a significant association between age of parent/guardian, educational level, occupation and malaria prevalence (χ^2=12.90, p=0.005, α=0.05), (χ^2=13.15, p=0.004, α=0.05) and (χ^2=28.71, p<0.001, α=0.05) respectively.

Association between LLIN ownership and use fever, anaemia, malnutrition, and antimalarial drugs use and malaria prevalence

Table 1 shows that the there was no significant association between LLIN ownership, usage of the net (sleeping inside an LLIN) and prevalence of malaria (χ^2=0.17, p=0.677, α=0.05) and (χ^2=0.90, p=0.342, α=0.05) respectively. There was also no significant association between fever (temperature ≥ 37.5ºC) and malaria prevalence (χ^2= 0.75, p=0.387, α=0.05). There was a significant association between history of fever within one week and malaria prevalence (χ^2=5.28, p=0.022, α=0.05). There was no significant association between Hb level, nutritional status and malaria prevalence (χ^2=23, p=0.892, α=0.05) and (χ^2=3.52, p=0.172, α=0.05) respectively.

Factors influencing malaria prevalence

Background characteristics of the children and the odds of malaria infection

Table 2 shows that the odds of having malaria among female children was 1.29 times higher than among male children, however, the difference was not statistically significant [AOR=1.29 (95% CI: 0.62, 2.69); p=0.494]. Children residing in H-A communities were 96% less likely to have malaria as compared to those in L-A [AOR=0.04 (95% CI: 0.02, 0.12); p<0.001]. Children aged 12-23 months were 2.49 times more likely to have malaria as compared to those aged 6-11months, but the difference was not statistically significant [AOR=2.49 (95% CI: 0.62,10.08); p=0.200]. Older children aged 24-35, 36-47 and 48-59 months were 6.73, 4.10 and 7.16 times more likely to have malaria as compared to children aged 6-11 months [AOR=6.73 (95% CI: 1.67, 27.15); p=0.007], [AOR=4.10 (95% CI: 0.99, 16.96); p=0.051] and [AOR=7.16 (95% CI: 1.71, 29.97); p=0.007] respectively.

Children who slept inside LLINs were 12% less likely to have malaria as compared to those who did not, however, the difference was not statistically significant [AOR=0.88 (95% CI: 0.44, 1.78); p=0.727]. Children with severe and moderate malnutrition were 41% and 10% less likely to have malaria as compared to those with normal nutritional status, but the difference was not statistically significant [AOR=0.59 (95% CI: 0.05, 7.12); p=0.680] and [AOR=0.90 (95% CI: 0.05, 15.66); p=0.944] respectively (Table 2).

Children with a history of fever within one week before the survey were 4.91 times more likely to have malaria as compared to those with no history of fever [AOR=4.91 (95% CI: 2.40, 10.08); p<0.001]. Children with fever (Temp≥ 37.5ºC) were 7.01 times more likely to have malaria as compared to those without fever, but the difference was not statistically significant [AOR=7.01 (95% CI: 0.31, 156.53); p=0.219] (Table 2).

Children with moderate anaemia (Hb=8.0-10.99g/dl) and low Hb (Hb<8.0g/dl) were 2.49 and 4.15 times more likely to have malaria as compared to those with normal Hb (Hb≥11.0g/dl) [AOR=2.49 (95% CI: 1.12, 5.53); p=0.026] and [AOR=4.15 (95% CI: 1.22, 4.17); p=0.023] respectively (Table 2). Children residing in H-A were 96% less likely to have malaria as compared to those in the L-A [AOR=0.04 (95% CI: 0.02, 0.12); p<0.001] (Table 2).

Background characteristics of parent/guardians and the odds of malaria infection in their children

There was no significant difference between children of parents with primary, JHS and SHS/tertiary education as compared to those

with no formal education and having malaria. Parent/guardians with primary, JHS and SHS/tertiary education levels were 29%, 49% and 61% less likely to have malaria as compared to those with no formal education [AOR=0.69 (95% CI: 0.22, 2.15); p=0.523], [AOR=0.39 (95% CI: 0.12, 1.28); p=0.121] respectively.

Characteristics	Low-Altitude [n=174] n (%)	High-Altitude [n=151] n (%)	Adjusted Odds Ratio [AOR]	95% CI	p-value
Sex					
Male	83 (47.7)	73 (48.3)			
Female	91 (52.3)	78 (51.7)	1.29	(0.62, 2.69)	0.494
Age group					
6-11	23 (13.2)	25 (16.6)			
12-23	35 (20.1)	35 (23.2)	2.49	(0.62,10.08)	0.200
24-35	41 (23.6)	36 (23.8)	6.73	1.67, 27.15)	0.007
36-47	34 (19.5)	28 (18.5)	4.10	(0.99, 16.96)	0.051
48-59	41 (23.6)	27 (17.9)	7.16	(1.71, 29.97)	0.007
Mid-Upper Arm Circumference (MUAC)					
Normal	167 (96.0)	141 (93.4)			
Severe malnutrition	4 (2.3)	2 (1.3)	0.59	(0.05, 7.12)	0.680
Moderate malnutrition	3 (1.7)	8 (5.3)	0.90	(0.05, 15.66)	0.944
Used LLIN last night					
No	35 (20.1)	37 (24.5)			
Yes	139 (79.9)	114 (75.5)	0.88	(0.44, 1.78)	0.727
Haemoglobin level					
Normal (Hb≥11.0)	58 (33.3)	49 (32.5)			
Mild anaemia (Hb=8.0-10.9)	100 (57.5)	90 (58.6)	2.49	(1.12, 5.53)	0.026
Low-Hb (Hb<8.0 g/dl	16 (9.2)	12 (8.0)	4.15	(1.22, 4.17)	0.023
Fever (Temp≥ 37.5ºC					
No	171 (98.3)	150 (99.3)			
Yes	3 (1.7)	1 (0.7)	7.01	(0.31, 156.53)	0.219
History of Fever within one week before the survey					
No	116 (66.7)	118 (78.2)			
Yes	58 (33.3)	33 (21.9)	4.91	(2.40, 10.08)	<0.001
Characteristics of parent/guardian					
Educational level					
None	17 (9.8)	10 (6.6)			
Primary	38 (22.0)	20 (13.3)	0.69	(0.22, 2.15)	0.523
JHS	96 (55.5)	80 (53.0)	0.51	(0.18, 1.44)	0.204
SHS	23 (13.2)	41 (27.2)	0.39	(0.12, 1.28)	0.121
Landscape					
Low-Altitude	-	-			
High-Altitude	-	-	0.04	(0.02, 0.12)	<0.001

Table 2: Background characteristics of the children and their parents/guardians and odds of malaria.

Discussion

The aim of this study was to investigate the prevalence of malaria among children under the age of 5 years residing in H-A and L-A as well as to identify the risk factors associated with malaria. Based on the results of this study, the socio-demographic factor closely related to the risk of malaria was the age of children. It was found that older children 24 months and above were more likely to have malaria as compared to children aged 6-11 months. The study revealed that children aged 24-35,36-47 and 48 and above were 6.73, 4.10 and 7.16 times more likely to have malaria than those age 6-11 months (p=0.007), (p=0.051) and (p=0.007) respectively. Similar studies also indicated that an older child was associated with a higher risk of malaria [12]. Age of child could also contribute to the individual's way of life, where older children could move about freely and may go outside more often and therefore may be more susceptible to mosquito bites, and thus malaria.

This study did not find any association between educational level of parents/guardians and malaria infection in children. Even though children whose parents attained primary, JHS and SHS educational level were 31%, 49% and 61% times less likely to have malaria, the differences were, however, not statistically significant (p=0.523), (p=0.204) and (p=0.121) respectively. It is assumed that more educated individuals have a better understanding of health-related issues. With regard to malaria, compared to children who had caregivers with a secondary education, those with caregivers who had an unspecified level of education or no education were more at risk.

This current study revealed that ownership of LLINs was high 96.9% and it was above 95.0% in both L-A and H-A (96.6% vs. 97.4%). This implies that the LLIN distribution channels in the municipality are effective. Overall usage of LLIN was 77.9% with 79.9% in L-A and 75.5% in the H-A. These findings are higher than what was reported by the GDHS, (2014)[6], which found ownership of LLIN in rural communities to be 79%. Usage of LLINs was found to be 66.9% in rural areas. Although LLIN use plays a key etiologic role in malaria prevention in endemic countries, the use of LLIN was not significantly associated with a child's malaria status. This result is in agreement with those of other studies [12], which also found no evidence of lower odds of malaria infection among children sleeping under LLIN in relation to those not. This observed lack of association in our study could possibly be attributed to an inconsistent or inappropriate use of the nets or perhaps a child being exposed to mosquito bites during other times of the day or evening when the net was not in use.

In this current study, overall, malaria prevalence by RDT was 129 (39.7%) with 99 (56.9%) among children from L-A and 30 (19.9%) among H-A children. Malaria prevalence by microscopy was 77 (23.7%) with 72 (41.4%) among children from L-A and 5 (3.3%) among H-A children. The low rates in the H-A are similar to findings in other H-A areas in Butajira in Ethiopia 2011 (4.4 %) [13] and in Jimma town (5.2 %) in 2010 [14] Fever prevalence was 4 (1.2%) with 3 (1.7%) among L-A and 1 (0.7%) among H-A children. Prevalence of a history of fever was 91 (28.0%) with 58 (33.3%) among L-A and 33 (21.9%) among H-A children. The

current study has shown that history of a fever within the past one week was higher among children from L-A than H-A. Children with a history of fever were 4.91 times more likely to have malaria as compared to those without (OR= 4.91, p<0.001).

The current study found malaria infection to be associated with anaemia (Hb<11 g/dl). Children with mild anaemia and Low-Hb were 2.49 and 4.15 times more likely to have malaria as compared to those with normal Hb (OR=2.49, p=0.026) and (OR=4.15, p= 0.023) respectively. The findings from this study are in accordance with other studies [12], which also found anaemia to be associated with P. falciparum infection (OR=10.8, p<0.001).

The findings from the current study showed that there was a significant association between malaria infection and landscape. Children in the H-A were 96% less likely to be infected with malaria (AOR=0.04, p<0.001). This is similar to findings from a study conducted in Ethiopia [15], which reported high altitude to be a protective factor against malaria infection. Similarly, the findings from this study are in agreement with findings from other studies [16], which reported that the odds of malaria for a child decreased with an increase in cluster altitude.

Limitations

The limitations of this study include the fact that the survey was conducted in November which coincided with the end of the rainy season with high malaria transmission and does not provide all information on factors determining the risk of malaria infection throughout the year. Enquiring about ownership and use of LLINs was based on parents report and no observation was made to confirm the response by interviewers.

Conclusion

In conclusion, malaria burden among children 24 months and above residing in L-A is high in the rural communities in the Hohoe Municipality. LLIN ownership and usage is high in both L-A and H-A. Additional targeted control measures for malaria control in the L-A areas such as education on appropriate and consistent use of LLINs, as well as education on home management of malaria and targeted screening with RDTs and treatment of older children, would be required.

List of Abbreviations

RDT: Rapid Diagnostic Test; LLIN: Long lasting Insecticide-Treated Net; GSS: Ghana Statistical Service; GDHS: Ghana Demographic Health Survey; GHS-ERC: Ghana Health Service Ethical Review Committee; EIR: Entomological Inoculation Rate; HRP2: Histidine Rich Protein 2; WBCs: White Blood Cells; ACT: Artemisinin-based Combination Therapy; WHO: World Health Organization; NMCP: National Malaria Control Programme; HMHD: Hohoe Municipal Health Directorate; MHMT: Municipal Health Management Team; HMMD: Hohoe Municipal Meteorological Department; UHAS: University of Health and Allied Sciences; NMIMR: Noguchi Memorial Institute of Medical Research; JHS: Junior High School; SHS: Senior High School; Hb: Haemoglobin; MUAC: Mid Upper Arm Circumference; AOR: Adjusted Odds Ratio; H-A: High Altitude; L-A: Low Altitude.

Declarations

Ethics and consent statement

Ethical clearance was obtained from the Ghana Health Service Ethical Review Committee (GHS-ERC) with the approval identity (GHS-ERC; 14/05/15). Permission was also sought from the chiefs and elders of the communities. Moreover, the parents/guardians of the children consented to be part of the study.

Authors' contributions

MK conceived the study. MK, MA, WT, WKA and RO did the data analysis and wrote the methods section. MK, MA, WT, MT and ET and were responsible for the initial draft of the manuscript. All authors reviewed and approved the final version of the manuscript.

Acknowledgements

We are grateful to Mr. King Harrison Kpo for reading the slides, the Hohoe Municipal Health Management Team for their assistance during the survey. We are thankful to all the parents/guardian for giving us their consent to enroll their children, and we gratefully acknowledge the children who participated in the study.

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