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Plasmodium Infection in School Children, and Knowledge, Attitudes and Practices (KAP) of Parents/Guardians in Tombel, Kupe-Muanenguba Division, South West Region, Cameroon

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Abstract

Background: Despite the package of interventions put in place by the World Health Organisation (WHO) to reduce malaria burden, the disease remains a public health problem. This study was therefore undertaken to detect *Plasmodium* infection in school children and evaluate the parents'/guardians' Knowledge, Attitudes, and Practices (KAPs) pertaining to the disease in Tombel, Kupe-Muanenguba Division, South West Region, Cameroon.

Method: A cross-sectional school-based study involving a total of 400 children with ages between 2 to 15 years was carried out in Tombel town to test for the presence and density of *Plasmodium* parasites using microscopy. Moreover, a semistructured questionnaire was given to the parents/guardians to obtain useful information.

Results: The overall prevalence of malaria in the study population was 63% and showed no statistically significant variation with gender, age, and body temperature. Prevalence was significantly (χ^2=33.67, P=0.00021) higher in Standard Bilingual Nursery and Primary School (STABINAPS), Kingdom Bilingual Nursery and Primary School (KIBINAPS), Group I, Government Bilingual High School (GBHS) and Group II than the rest of the schools. The minimum, maximum, and Geometric Mean Parasite Densities (GMPD) were 100 parasites/μL of blood, 18,800 parasites/μl of blood, and 4,479 parasites/μl of blood, respectively. The geometric mean parasite density was significantly 7 times higher in children who had fever (16,469 parasites/μl of blood) than those who did not have fever (2,357 parasites/μl of blood) (P=3.45e-05). The overall knowledge on malaria was significantly dependent on gender, age, marital status, educational level, and occupation of parents/guardians ($P<0.05$). The statistically significant risk factors were: none use of mosquito bed nets, no treatment of the nets, and living in the quarters Peng, Ward I, Ward II, and Ward III ($P<0.05$).

Conclusion: Malaria prevalence was high, and knowledge, attitudes, and practices were inappropriate. There is a need for more distribution of ITN and sensitization on the benefits of its usage alongside other control measures and environmental management in order to successfully curb the scourge which is malaria.

Keywords: Malaria; Prevalence; Density; Knowledge; Attitude and Practices (KAPs); Tombel

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Introduction

Malaria is a life-threatening disease caused by the *Plasmodium* parasite, which is transmitted to humans through the bite of an infected female *Anopheles* mosquito. Its transmission is usually associated with topography, climate and socioeconomic conditions [1,2]. The problem of the disease is aggravated by changing climate, poverty, and lack of efficient controlling mechanisms. Moreover, the emergence of new parasite strains, expansion of host range due to human population growth and movement, land use change, increasing vectorial capacity, and deteriorating public health infrastructure contribute to spread of the disease [3,4]. Due to climate and ecological diversity, as well as variations in local perceptions, there is apparent variation and instability in the epidemiology of its transmission and prevalence.

Cameroon is among the 15 highest burden malaria countries and has 3% of all malaria cases; this represents the 3rd highest number of malaria cases in Central Africa. In Cameroon, malaria accounts for over 30% of all medical consultations; 21% laboratory-confirmed malaria cases, 19% deaths in health units, and 48% of all hospital admissions. The prevalence of malaria in the South West Region of Cameroon in school aged children is 33.8% [5], responsible for school absenteeism [2] and causing the death of many children before their fifth birthday. In Tombel, malaria prevalence increased in the Tombel Health District (THD) from 26.7% in 2010 to 30.7% in 2011 but dropped to 22.7% in 2012 and then increased in 2013 to 29.5% with the number of confirmed cases highest from June to August (peak of rainy season), with children having the highest prevalence (40.7%) [4]. Several studies show that monthly figures of malaria among in-patients fluctuate seasonally; low values in the dry season and high values in the rainy season [2,4]. However, the alertness and measures taken by the inhabitants against malaria do not vary throughout the year. Awareness of the prevalence, intensity, morbidity, and mortality of malaria is vital, and managing its impact is for human control. It is therefore imperative to evaluate the prevalence and intensity of malaria in school children, and evaluate the parents'/guardians' Knowledge, Attitudes, and Practices (KAPs) pertaining to the disease in Tombel, with the goal to raise awareness and develop effective policies that will allow for more efficient use of resources to fight against the disease.

Material and Methods

Study area

Tombel is a town in the Southwest Region of Cameroon (Figure 1), in the north of the Mungo Valley. It is situated between latitude 04°16' and 05°15' north and longitude 09°13' and 09°15' East. It covers a surface of 1,007 Km^2 and has an estimated population of 110,178 inhabitants according to the 2005 census. However, the town's population has drastically dropped to almost half (about (57017 inhabitants) due to the Anglophone crisis that has caused emigration to the nearby French speaking towns [6].

Study populatioan

The study participants included Primary School Pupils and Secondary School Students of at most 15 years old in Tombel town. The Secondary Schools that took part in the study included: Government Bilingual High School (GBHS), Government Secondary School (GSS), Government Technical High School (GTHS), and Oxford Academy Complex (OAC). The Nursery and Primary Schools were: Standard Bilingual Nursery and Primary School (STABINAPS), Kingdom Bilingual Nursery and Primary School (KIBINAPS), Presbyterian Nursery and Primary School (PNPS), Catholic Nursery and Primary School (CNPS), Government School Group I, II, and IV. These give a total of 11 schools.

Inclusion and exclusion criteria

School children of at most 15 years old whose parents/guardians had signed the informed consent form and had been permitted by school authorities. School children who had taken antimalarial drugs within the past two weeks were excluded.

Sample size

The sample size was calculated using Lorenz's formula (Stat Calc of EPI Info software). Using the prevalence of 40.7% from a study on the proportion of malaria in children in the study area [4], with an 80% power to detect significant associations or differences and a 5% accepted margin of error, the minimal sample size estimate was 370.

Data collection and parasitology examination

A semistructured questionnaire was administered to adults (parents/guardians/caregivers) to obtain information on knowledge, attitude and practices pertaining to malaria, as well as demographic information and risk factors. The procedure for the preparation of slides according to Azikiwe et al. [7] was used as described below. The third finger of the left hand was wiped at its tip with a spirit swab and allowed it to dry. The finger was pricked with a disposable lancet and allowed for the blood to ooze out. A small drop of blood was placed in the centre of a precleaned, labelled slide. The Giemsa-stained blood films were examined under an x100 (oil immersion) objective of a light microscope. Slides were considered positive when asexual forms and/or gametocytes of any *Plasmodium* species were observed on the blood film. The malaria parasite density was determined by counting the number of parasites per 200 leukocytes on a thick blood film and multiplying the parasite count with an assumed average white blood cell count of 8,000 per microliter of blood [7].

$$Parasite\ density = \frac{number\ of\ parasites\ counted}{leukocytes\ counted} \times 8000\ WBC / \mu L\ blood$$

Statistical analysis

Data was entered into spread sheets using Microsoft Excel and analysed with R Language in its interface Rstudio Pro version 1.3.1093 (RStudio, inc., Boston, MA). Proportions were compared using Fisher's and Chi-square test (χ^2). Differences between group means were compared using independent sample t-test, Wilcoxon and Kruskal-Walli's test where appropriate. Variations in mean prevalence between groups were compared using Analysis of Variance (ANOVA). Significant levels were measured at 95% Confidence Interval (CI) with significant difference set at P<0.05.

Ethical considerations

The National Committee on Research Ethics for Human Health provided ethical clearance. The Declaration of Helsinki was followed in the final stages of this work. All ethical guidelines pertaining to doing research with marginalized populations, like inmates, have been adhered to. There were no external restrictions on the donor ability to attend the research.

Results

The overall prevalence of malaria in the population was 63%. Table 1 shows the prevalence and density of infection with respect to sex, age, body temperature, and school. It follows from the analysis of this table that the prevalence of malaria in males was 62.64% while that of females was 63.27% but the difference was not statistically significant (0.98). The mean parasite density was higher in females than in males, but the difference was also not significant (P=0.45). There was no significant difference in the prevalence of malaria between age groups (P=0.69). However, it was highest in the age group 2 to 5 years (65.57%) and lowest in the group 11 to 15 years (60.61%). Similarly, Table 1 shows that the lowest mean parasite density was observed in the group 11 to 15 years (2106 parasites/µL of blood) but without significant difference (0.33) in parasite density between the age groups. The prevalence of malaria was comparable between the various schools (χ^2=33.67, P=0.00021) and indicated a significant difference. STABINAPS had the highest prevalence (78.38%), while OAC had the lowest (34.62%). Moreover, the mean parasite density was higher in CNPSS (3340 parasites/µL of blood) and lower in GBHS (1583 parasites/µL of blood) but with no significant difference

Table 1: Prevalence and density of infection with respect to sex, age, body temperature, and school.

Parameter	No. examined	Prevalence % (n)	Level of significance Chi square P-value	Geometric Mean Parasite density (parasites/μL of blood)	P-Value
			Gender		
Male	174	62.64 (109)	χ^2=0.00062 P=0.98	2363	P=0.45
Female	226	63.27 (143)		2615	
			Age group in years		
02-05	61	65.57 (40)	χ^2=2.19 P=0.69	2462	P=0.33
06-10	174	64.37 (112)		2849	
11-15	165	60.61 (100)		2106	
			Body temperature in °C		
Febrile	6	100 (6)	P=0.089	16496	P=3.45e-05
Afebrile	394	62.44 (246)		2357	
			Schools		
STABINAPS	37	78.38 (29)	χ^2= 33.67 P=0.00021	2721	P=0.70
KIBINAPS	58	75.86 (44)		2658	
Group I	56	75.00 (42)		2307	
GBHS	47	70.21 (33)		1583	
Group II	49	67.35 (33)		2768	
GTHS	12	58.33 (7)		2148	
PNPS	56	50.00 (28)		2737	
CNPS	21	47.62 (10)		3340	
Group IV	21	47.62 (10)		3085	
GSS	17	41.18 (7)		3176	
OAC	26	34.62 (9)		2151	

Table 2: Knowledge on malaria with respect to sociodemographic factors.

Variables in parents/guardians		No. examined	Malaria Appropriate knowledge % (n)	Level of Significance
Sex	Male	119	34.45 (41)	χ^2=4.03 P=0.045
	Female	281	45.915 (129)	
Age group	≤ 25	82	1.22 (1)	P=4.99e-04
	26-35	101	57.43 (58)	
	36-45	83	40.96 (34)	
	46-55	93	65.59 (61)	
	≥ 56	41	39.02 (16)	
Marital Status	Single	142	23.24 (33)	χ2=39.442 P=2.72e-09
	Married	239	55.23 (132)	
	Divorced	19	26.32 (5)	
Educational level	No formal	16	25.00 (4)	P=0.027
	Primary	89	38.20 (34)	
	Secondary	215	40.40 (87)	
	Tertiary	80	56.25 (45)	
Occupation	Teaching	64	82.81 (53)	P=4.99e-04
	Farming	185	40.54 (75)	
	Business	80	41.24 (33)	
	Student	63	1.59 (1)	
	Military	4	100 (4)	
	Medical personnel	4	100 (4)	

between the schools (P=0.70).

Table 2 shows the knowledge on malaria with respect to sociodemographic factors. The proportion of females (45.915%) who had appropriate knowledge on malaria in the study population was comparable to their male (34.45%) counterparts and the difference was significant (χ^2=4.03, P=0.045). With respect to age group, only 1.22% of the population in the age group ≤ 25 years had appropriate knowledge on malaria. The age group 46 to 55 years had a significantly higher (65.59%) proportion of persons with appropriate knowledge than the rest (P=4.99e-04). The level of appropriate knowledge in parents/caregivers of children with tertiary level of education (56.25%) was significantly higher (P=0.027) and lower in persons with no formal education (25.00%). The proportion of the population that had appropriate knowledge was significantly different between occupations (P=4.99e-04). All military and medical personnel had appropriate knowledge while only 1.59% of students had it. Moreover, 82.81% of teachers, 40.54% of farmers, and 41.24% of businessmen had appropriate knowledge as shown in Table 2.

Risk factors of malaria

Table 3 shows that the risk of acquiring malaria infection was

Table 3: Risk factors of malaria.

		No. Examined	Prevalence % (n)	Relative Risk (RR)	P-value
Quarters	Peng	64	85.94(55)	2.39	0
	Ward I	57	80.70 (46)	2.24	0.002
	Ward II	43	65.12 (28)	1.81	0.025
	Ward III	45	75.56 (34)	2.1	0.002
	Ward IV	22	45.45 (10)	1.26	0.56
	Ward V	36	52.78 (19)	1.47	0.296
	Ward VI	28	57.14 (16)	1.59	0.17
	Ward VII	26	50.00 (13)	1.39	0.4
	Ward VIII	7	57.14 (4)	1.59	0.4
	Ward IX	16	31.25(5)	0.86	1
	Ward X	31	41.94 (13)	1.16	0.78
	Ward XI	25	36.00 (9)	1	-
Type of house	Cement Block	180	62.78 (113)	1	0.93
	Plank	220	63.18 (139)	1.006	
Presence of Bush	Yes	317	64.98 (206)	1.17	0.93
	No	83	55.42 (46)	1	
Presence of stagnant water	Yes	198	61.62 (122)	1	-
	No	202	64.36 (130)	1.04	0.13
Knowledge level	Appropriate	170	61.18 (148)	1	-
	Inappropriate	230	64.35 (104)	1.05	0.53
Sleeping Time (PM)	07-08	58	63.79 (37)	1.18	0.29
	08-09	128	65.62 (84)	1.22	0.1
	09-10	137	64.96 (89)	1.21	0.14
	≥ 10	78	53.85 (42)	1	1
Use of Bed nets	Yes	75	52.00 (39)	1	-
	No	325	65.54 (213)	1.26	0.034
Treatment of Bed Nets	Yes	18	16.67 (3)	1	-
	No	57	63.16 (36)	3.79	0.0009
Use of Mosquito Repellents	Yes	76	63.16 (48)	1.003	-
	No	324	62.96 (204)	1	0.99
Use of Screen Windows	Yes	116	61.21 (71)	1	-
	No	284	64.08 (182)	1.05	0.98
Number of Meals	One	9	77.78 (7)	1.3	0.17
	Two	82	59.76 (49)	1	-
	Three	263	62.74 (165)	1.01	0.69
	Four	46	67.39 (31)	1.13	0.34

significantly higher in Peng, followed by Ward I, Ward III, and Ward II. The most exposed quarter was Peng and the least exposed was Ward IX. People living in plank houses were exposed to malaria 1.006 times more than those living in cement brick houses, but the difference in the risk were not significant (P=0.93) as shown in Table 3 below. Those who usually had bushes around their house were 1.17 times more exposed than those who did not, but the difference was not significant (P=0.93).

There was no significant difference (P=0.13) in the risk of acquiring malaria between those who usually had stagnant water around their house and those who did not. Inappropriate knowledge on malaria was 1.05 times more exposed to malaria than those with appropriate knowledge, but the difference was not significant (P=0.53). Those who did not use mosquito bed nets were significantly exposed to malaria 1.26 more (P=0.034) than those who did. Those who never treated their mosquito nets were significantly more exposed to malaria, 3.79 times more than those who treated their nets. Those who used mosquito repellents were 1.003 times more exposed to the risk of infection than those who did not use them, but the difference was not significant (P=0.99).

Discussion

The overall prevalence of malaria in the study population (63%) was greater than the 40.7% prevalence obtained by Fokam et al. [4]

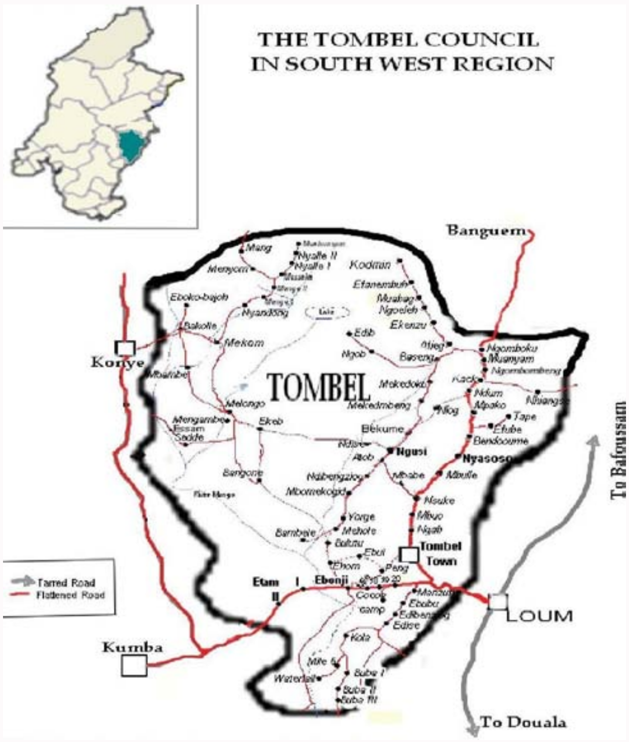

Figure 1: The Map of Tombel [6].

in a hospital-based study in Tombel Health District. It is also greater than that of Lehman et al. [8] who reported 45.47% prevalence among school children in Douala, Cameroon and that of Teh et al. [9] with a prevalence of 46.7% in children aged at most 15years in Batoke, in the Mount Cameroon Area. The prevalence obtained in this study was similar to the 60.5% prevalence obtained by Ndamukong-Nyanga et al. [10] in a study in the Mount Cameroon Area in children less than 15 years old in Fako Division. However, the overall prevalence of malaria in this study in Tombel (63%) was higher than that reported in other areas of the South West Region of Cameroon by previous studies; 33.3%, 27.7%, 20.1%, 33.7%, and 27.4% [11-14] in the Mount Cameroon area and in Limbe [15], respectively. The high prevalence observed in this study could be as a result of the study period; the onset of the rainy season with less frequent heavy rains and little or no run-off, which might have created pools of water that, could serve as favourable breeding sites for mosquitoes [16]. Moreover, the high temperatures and high humidity during the onset of the rainy season favour the development, survival, and biting activities of mosquitoes [3,17]. These contribute to the reasons why the months of April and May are considered as the peak malaria transmission period in the South West Region of Cameroon [14]. The increase in prevalence could also be due to continuous lapses in malaria control measures taken by the inhabitants of Tombel town.

Although not statistically significant, female children were found to have a higher prevalence of malaria than male children just like in the previous findings of Fokam et al. [4]. This might be due to the fact that most female children get up before dawn or stay up into the night to perform household chores that could expose them to mosquitoes and consequently malaria infection. The findings are in line with those of Kimbi et al. [18], Teh et al. [14] and Nlinweh et al. [19] whose studies showed that females were significantly more infected with malaria parasites than males. But this study was in contrast with that of Sultana et al. [20], Bamou et al. [21], and Nyasa et al. [12] who reported higher malaria prevalence in males than in females and associated it with the fact that, men frequently stay out of their homes late at night, carry out more outdoor activities, leave their homes very early in the morning before it's dawn to go to their farms and often spend several days living in their farm houses, as such, exposing themselves to mosquitoes.

Although not significant, it is not surprising that children of the age group 2 to 5 years had the highest prevalence when compared to older children, just like with the findings of Fokam et al. [4] in Tombel, Kimbi et al. [18] and Teh et al. [14]. This could be because children under 5 years are more vulnerable to the disease in areas of high transmission as naturally acquired immunity builds up in older children following repeated exposure to the parasite [22]. These results are different from that of Bamou et al. [21] whose highest prevalence was found in children within the 6 to 15 years age range, that of Ebai et al. [23] where malaria prevalence was found to be higher among children aged 5 to 15 years and that of Apinjoh et al. [11] and Bate et al. [24] whose highest malaria parasite prevalence was recorded in children aged 5 to 9 and 5 to 10 years respectively. Their findings were attributed to the playful and adventurous nature of children of this age group in the fields which expose them to mosquitoes.

With respect to schools, the prevalence of malaria was significantly different. STABINAPS had the highest prevalence (78.38%) followed by KIBINAPS, Group I, GBHS, and Group II. The prevalence could be higher in the above-mentioned schools because they are situated in highly risked quarters and mostly made up of children from such quarters (Peng, Ward I, Ward II, and Ward III). OAC had a lower prevalence (34.62%) than the rest of the schools, which had prevalence lower than the general prevalence (63%). OAC with the lowest prevalence is mostly made up of children from the less risked quarters, especially Wards IX, X, and XI with colder temperatures, and less surrounding bushes, and close proximity to the hospital despite the fact that it is a Secondary School made up of older children with stronger immunity.

The minimum, maximum, and geometric mean (SD) parasite densities were 100 parasites/µL of blood, 18,800 parasites/µL of blood, and 4,479 (4309.432) parasites/µL of blood, which is almost double of what was reported by Teh et al. [14] in the Mount Cameroon area. The GMPD was less than 6,869 parasites/µL of blood reported by Nyasa et al. [12] in Nkongho-mbeng.

The GMPD was significantly 7 times higher in children who had fever (16469 parasites/µL of blood) than those who did not have fever (2357). The absence of fever in most children could be due to adaptive immunity which was acquired as a result of repeated infections with the parasite. In regard to malaria, people are either immune or non-immune. Immune people often have a better chance of tolerating the effects of malaria and surviving the disease than non-immune people. Various adaptive immunity techniques/processes against plasmodia have been defined, namely: Anti-disease immunity (protection against clinical disease), antiparasite immunity (protection against parasitemia), and premunition (protection against new infections) [25]. This could be the reason for the lower parasite density in afebrile children. This result was similar to that of Chipwa and Sumaye [26] in Tanzania.

Even though not statistically significant, the prevalence of malaria was seen to be associated with the presence of bushes and the presence of stagnant water around houses. Participants living in bushy environments had higher malaria prevalence than those living in non-bushy areas. In the same line, those residing around stagnant water had higher malaria prevalence than those residing in non-stagnant water areas. These findings are consistent with other studies conducted in Bomaka and Molyko, located on the slope of mount Cameroon [27], and with a study on individual and housing factors influencing the incidence of malaria in Ethiopia [28], where residing around bushy areas and areas of stagnant water were identified as risk factors for malaria. This also agrees with the recent findings of Nyasa et al. [12] in Nkongho-mbeng in Nguti Subdivision of the Kupe-Muanenguba Division in South West Region.

Furthermore, those who lived in plank houses also showed a higher prevalence than those who lived in cement block houses, similar to what was reported by Teh et al. [14] and Nyasa et al. [12] that plank houses lack ceilings and have crevices for mosquito entry, providing a favourable microenvironment for mosquitoes and means of entry into the house. More so, the prevalence of malaria was significantly higher in children who were not using ITNs compared to those who were using ITNs. ITNs is a highly effective means of preventing malaria infection and reducing associated morbidity and mortality, particularly in endemic areas. This finding corroborates those of Ntonifor and Veyufambom [29] and Nlinweh et al. [19] who found out that malaria occurred at a higher prevalence among non-users of LLINs than in users of LLINs. The use of LLINs offers a degree of protection against female Anopheles mosquito bites because they bite mostly in the night. Yang et al. [30] also supported the effectiveness of treated nets in the control of malaria. Similarly, there was a lower prevalence in those who treated their nets than those who never did. This could be due to repeated impregnation of the net with more insecticide or a kind different from what was previously used, which increases the insecticidal dose and combats insecticide resistance respectively [19].

Contrary to what was expected, the disease prevalence was higher in those who went to bed before 10 pm than those who went after 10 pm, even though the difference was statistically not significant. It could be that, even though they retired to bed early, they were not still protected from infective mosquito bites by sleeping under ITNs or LLINs. This is made evident by the results that only 18.8% of the population slept under mosquito bed nets, 19% used mosquito repellents, and only 25% killed mosquitoes actively with brooms, candles etc. Even though not significant, the disease prevalence was higher in those who used mosquito repellents than those who did not. This was contrary to the findings of Nlinwe et al. [19] in which mosquito repellent body creams and sprays significantly reduced the risk of acquiring malaria. The higher risk of disease in those who used repellents in this study could be as a result of repeated use of the same repellent. Several studies showed that, after repeated application of chemicals, mosquitoes develop insecticide resistance, which means that they are no longer killed by the insecticides. This implies that a large number of mosquitoes will survive in the community leading to a rise in the risk of malaria infections and the number of people being affected [16].

Again, the results showed that those who did not have screen windows were more exposed to the risk of acquiring malaria than those who had, but the difference was not significant. This was in line with the study of Nlinwe et al. [19] in Foumbot where window and door nets protected the people significantly from the disease even without being impregnated with chemicals.

With respect to the number of meals children ate per day, there was no statistically significant difference in the prevalence; however, those who had just one meal per day presented the highest prevalence. This could be due to malnutrition and hunger, torturing psychology which depreciate the immune system and make children more vulnerable to infections. All these factors, which are known to be usually associated with poverty and illiteracy, contribute to increased malaria transmission and high levels of mortality in Africa [20]. Several studies support that chronic malnutrition is relatively consistently associated with high-density parasitaemia and anemia, both associated with severe malaria. Moreover, severe acute malnutrition is believed to be linked to intestinal malabsorption of medicines which can cause sub-optimal drug exposure and contribute further to poor patient outcomes and accelerated selection of antimalarial drug resistance [31].

Conclusion

It was discovered that the overall prevalence of malaria in the study population was 63%. This high prevalence was associated with climatic factors like bush and water, behavioural factors like reduced use of preventive measures and inadequate knowledge on malaria. An adequate follow-up to ensure effective execution of the recently launched third phase of LLINs distribution campaign in Cameroon is recommended.

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