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Socio-demographic and Environmental Factors Influencing asymptomatic Malaria and Anaemia Incidence among School Children in Fako Division, South West Cameroon

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Authors' contributions

This work was carried out in collaboration between all authors. Author JLNN designed the study, wrote the protocol, carried out field and laboratory work and wrote the first draft of the manuscript. Author HKK designed the study, wrote the protocol, carried out field work, read and corrected the manuscript. Author IUNS performed the statistical analysis, read and corrected the manuscript. Authors LE, MNN, YN and JNKN participated in the data collection and literature searches. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aim: This work was aimed to assess the influence of socio-demographic and environmental factors on the incidence of asymptomatic malaria and anaemia among pupils in Fako Division, southwest Cameroon.
Experimental Design: The study was a cross-sectional survey.
Place and Duration of Study: The study was carried out in Fako Division, southwest Cameroon -Bolifamba, Dibanda and Mutengene from February to March, 2013.
Methodology: A total of 316 pupils aged 4–15 years were studied. Data on socio-demographic and environmental factors was obtained from a semi-structured questionnaire. Blood samples were collected. Malaria parasite incidence and density

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were determined from Giemsa-stained thin and thick blood smears respectively. Haemoglobin (Hb) levels were determined using a haemoglobinometer.
Results: The overall incidence of asymptomatic malaria was 43.4% (CI=38-48.9). Malaria incidence was significantly highest (χ^2=7,*P*=0.03) in pupils of 6-10 years age group (49.0%, CI=42.1-59.9) when compared with their counterparts. Although not significant, malaria parasite incidence was higher in males, pupils with fever, highest in pupils of Bolifamba and poor social status than their respective counterparts. Geometric mean parasite density (GMPD) was significantly highest (Kruskal Wallis test, *χ^2=6.4, *P*=0.04) in Dibandathan other sites. Anaemia incidence was higher among inhabitants of Dibanda (56.7%) than other sites. Anaemia incidence was statistically higher (χ^2=5.6, *P*=0.02) in malaria positive pupils, highest in Dibanda (χ^2=27.244, *P*<0.001) and the middle class when compared with their respective counterparts. Mean HB was significantly higher in malaria negative (t=1-8, *P*=0.02), highest in the poor class (χ^2=13.4, *P*=0.001) and Mutengene (F=21.2, *P*=0.0001) when compared with their respective counterparts.
Conclusion: Sensitization on effective malaria control strategies needs to be emphasized so that a reduction in malaria burden can be achieved.

Keywords: Asymptomatic malaria; anaemia; prevalence; Socio-economic class; environmental factors.

1. INTRODUCTION

Malaria is a major cause of morbidity and mortality. The disease is endemic in sub-Saharan Africa including Cameroon where both clinical and asymptomatic malaria cases occur throughout the year [1] leading to anaemia. Despite the global fight against malaria as coordinated by the roll back malaria partnership [2] malaria continues to pose a health problem in Cameroon especially in the South West Region. This situation is a direct reflection of the socio-economic status of the inhabitants as well as environmental factors which favour the prevalence of the disease [3]. If malaria is diagnosed and treated in asymptomatic individuals it will help to reduce the number of clinical cases and consequently anaemia. As such, there is a need to obtain data on the prevalence of asymptomatic malaria in all age groups including school children in order to better plan control measures especially in endemic areas. Anaemia is an important manifestation of malaria [4]. The rate of development and the degree of anaemia depends on the severity and frequency of parasitaemia. Anaemia is most marked with *P. falciparum,* which invades red blood cells of all ages [4] and this species is the commonest in southwest Cameroon. Anaemia can contribute to poor oxygenation of tissues during a malaria infection. This can be severe enough to reduce supply of oxygen to mitochondria to dangerously low levels [5]. Thus, it can be a major component of malarial pathology. If left untreated, anaemia could be a major risk factor for mortality.

The method of malaria control adopted by the National Malaria Control Programme in Cameroon is the early detection of parasites in symptomatic people followed by treatment with artemisinin combination therapies to curb the disease burden. This control programme however usually leaves out individuals chronically infected with malaria parasites, but showing no symptoms [6]. Such asymptomatic infections do not only contribute to further transmission, but may also be taking their toll on the health status of the individual contributing to anaemia and or weakening of the individual's ability to fight off other infections [7]. Thus, there is a need to assess prevalence of asymptomatic malaria and anaemia among individuals especially children from time to time so that treatment can be effected leading to a reduction in transmission. It is postulated that the prevalences of malaria and anaemia generally decrease as incomes rise [8]. As such the socio-economic statuses of people have been found to be associated with the prevalence of both disease conditions [9], with lower prevalence attributed to a higher socio-economic status. The crumbling effects of malaria on the vulnerable population and the socio-economic development of the nation can be greatly reduced through preventive methods such as the use of Insecticide treated bed nets (ITNs) and proper environmental control.

Several studies have been carried out on malaria in the Mount Cameroon Region [3,6,10,11,12] but no study has specifically addressed the influence of both socio-economic and environmental factors on malaria and anaemia in school children in Fako Division. There is the need to generate data on such factors in this area in order to better plan control strategies against malaria and anaemia. Against this background the aim of this work was to assess the influence of socio-demographic and environmental factors on the prevalence of asymptomatic malaria and anaemia among school children in Fako Division, Southwest Cameroon.

2. MATERIALS AND METHODS

2.1 Study Sites

The study was carried out in Fako Division, southwest Cameroon at the following sites: Bolifamba (St. Jude Catholic School), Dibanda (All Saints Catholic School) and Mutengene (St. Joseph Catholic School). Mutengene (250m above sea level, longitude 09°18’ 82”E and latitudes 04°05’57’’ N) is a road-junction and semi-urban town where major roads from Buea, Limbe, Tiko and Douala converge. Dibanda (386m above sea level, longitude 09°18’ 47”E and latitudes 04°06’ 94’’N) is located north of Mutengene and is a rural area where subsistence agriculture is the major occupation of its inhabitants. Bolifamba (487m above sea level, longitude 09°18’ 51”E and latitudes 04°05’ 09’’N) is semi-urban and is located between Dibanda and Buea (the capital of the South West Region of Cameroon). These three localities are found in the Mount Cameroon area. Weather records for the Mount Cameroon area from the Cameroon Development Corporation indicate a mean relative humidity of 80%, an average rainfall of 4000 mm and a temperature range of 18-27°C. There are two distinct seasons-a cold rainy season which spans from mid-March to October and a warm dry season with frequent light showers which runs from November to mid-March.

2.2 Study Population

The study included 316pupils of both sexes aged 4-15 years. Pupils were enrolled into the study only if they fulfilled the following inclusion criteria: were pupils in one of the chosen schools, had received parental/guardian informed consent (came with signed informed consent forms), succumbed to the blood collection procedure.

2.3 Study Design

The study was a cross-sectional survey where blood samples were collected from children in the months of February and March, 2013. In each school, a sensitization rally was organized with the teachers of the schools to explain the purpose and benefits of the study (free malaria diagnosis for the children) before the sampling was done. Informed consent forms were sent to parents/guardians through the children stating the purpose of the study as well as the benefits and the amount of blood that had to be collected from each child. Only children who brought back signed consent forms were included in the study.

2.4 Collection, Preparation and Examination of Blood

Socio-demographic data was collected and recorded in a semi-structured questionnaire. Interviews were done in English and exceptionally in Pidgin English. The socio-economic status of each child was classified as poor (those living in plank houses, had no television/radio, no car, used firewood kitchen and pit toilets), middle class (those living in block houses, have flush toilets, television/radio, gas kitchen, but no car) and rich (those having all what the middle class children had and a car) [3]. Axiliary temperature of each child was recorded before blood collection. After cleaning the lobe of a finger with cotton wool soaked in methylated spirit, the finger was pricked using a sterile lancet. Blood was collected from the finger prick and used to prepare thick and thin blood films on labelled slides, air dried and Giemsa-stained for the assessment of parasite density and speciation respectively [13].

Haemoglobin measurements were done using a haemoglobinometer. The first drop of blood was wiped off with clean gauze and a drop of blood was applied to the haemoglbinometer strip inserted into the machine which gave a reading in grams/dl. A haemoglobin level of <11g/dl was classified as anaemic [14]

2.5 Assessment of Malaria Parasite Density

Blood films were stained with 10% Giemsa and examined under the oil immersion (x100) objective of an Olympus® BX40F light microscope (Olympus optical Co. Ltd., Japan). Thick films were considered positive when asexual forms (trophozoites and schizonts) and or gametocytes were present in the blood film. Parasites were counted against 200 leucocytes and expressed as parasites per microlitre (μl) of blood, assuming a white blood cell count of 8000/μl of blood. Slides were declared negative after observing at least 100 high power fields without detecting any parasites.

2.6 Statistical Analysis

Data was entered into spread sheets using Microsoft excel and analyzed with the statistical package for social sciences (SPSS) version 17 (SPSS, Inc., Chicago, IL, USA). Data was summarized into means and standard deviations, and percentages were used in the evaluation of the descriptive statistics. Proportions were compared using the chi-square test. Means ± standard deviations (SD) were compared using Kruskal Wallis test. The analysis of variance (ANOVA) was used where appropriate to compare means. Significant levels were measured at 95% confidence level with significant differences recorded at $p<0.05$.

3. RESULTS

3.1 Characteristics of the Study Population

A total of 316 pupils with a mean age of 8±2years (CI=57.2-67.8) were evaluated for socio-demographic and environmental influences on the incidences of malaria and anaemia. Out of the 316 pupils examined, 308 pupils responded to the questionnaires. Majority of the pupils examined were within the 6–10 years age group Table 1. The overall incidences of malaria and anaemia in the study population were 43.4% (CI=38-48.9) and 29.2% (n=90, CI=24.4-44.5) respectively Table 1.

3.2 Malaria Parasite Incidence and Density

In relation to age, pupils in the 6-10 years age group had the highest prevalence of malaria (49.0%, CI=42.1–55.9) when compared with those in the 0–5 (35.6%, CI=24.6–48.3) and 10-15 (32.2%, CI=21.7–44.9) years age groups. The difference was significant (χ^2=7, *P=0.03*) as shown in Table 2.

Table 1. Characteristics of the study population

Factor	Category	Number (%)
Sex	Male	164(51.9)
	Female	152(48.1)
Age (Years)	0-5	59(18.7)
	6-10	198(62.7)
	10-15	59(18.7)
Site	Bolifamba	62(19.6)
	Dibanda	60(18.9)
	Mutengene	194(61.4)
Socio-economic class	Poor	262(82.9)
	Middle Class	28(8.8)
	Rich	18(5.7)
Total		316(100)
Malaria parasite incidence		137(43.4)
Anaemia incidence (Hb<11g/dL)		90(28.5)
Fever incidence (temperature ≥37.5°C)		80(25.3)

Table 2. Malaria parasite incidence and density in relation to sex, age, fever, site and social status

Factor	Category	N	Malaria parasite Prevalence % (N)	χ^2 P- Value	GMPD	Range	Level of significance
Sex	Male	164	45.1 (74)	0.43	1974.5	218-5333	t=0.048
	Female	152	41.4 (63)	0.51	2330.1	615-16000	*P=0.168*
Age (years)	0-5	59	35.6 (21)	7	2246.4	600-5333	*χ^2=1.25
	6-10	198	49 (97)	0.03	2004.1	218-5600	df=2,
	10-15	59	32.2 (19)		2747.4	1142-16000	*P=0.54*
Fever	Fever (Temp ≥37.5)	80	46.3 (37)	0.37 0.55	2214.3	666-16000	t=0.39 *P=0.7*
	Normal (Temp<37.5)	236	42.4 (100)		2100.6	218-5600	
Site	Bolifamba	62	48.4(30)	0.84	1757.4	800-5600	*χ^2=6.43
	Dibanda	60	43.3 (26)	0.66	2381.2	218-5600	df=2
	Mutengene	194	41.8 (81)		2208.1	218-16000	*P=0.04*
Social status	Poor	263	45.2 (119)	3.84	2064.8	218-16000	*χ^2=4.8
	Middle class	28	39.3 (11)	0.15	2327.25	615-4800	df=2
	Rich	18	22.2 (4)		3718.0	2666-4800	*P=0.09*
Overall		316	43.4 (162)		2130.7	218-16000	

**Kruskal Wallis test*

Although not significant the prevalence of malaria parasites was higher in males (45.1%, 74), pupils with fever (46.3%, 37) and those of poor social status (45.2%,119) than their respective counterparts Table 2. Pupils living in Dibanda recorded a significantly higher GMPD (2381.2, range:800-5600) (Kruskal Wallis (*χ^2)=6.43, df=2, *P=0.04*) than those living in Mutengene (2208.1, range:218-16000) and Bolifamba (1757.4, 800-5600) as shown on Table 2.

3.3 Anaemia Incidence and Haemoglobin Levels

Overall, 47 (36.4%, CI=42.0-62.2) out of the 162 pupils that had malaria parasite were anaemic. The difference in incidence of anaemia when compared with malaria parasite negative pupils was statistically significant (t=1.8, *P=0.02*) as shown in Table 3. No significant difference in the incidence of anaemia was observed among the different age groups. In relation to the presence of fever the difference in incidence of anaemia between those who had fever and those who did not have approached significance (χ^2=3.5. *P=0.05*) Table 3.

The incidence of anaemia was significantly highest (χ^2=27.244, *P*<0.001) in children living in Dibanda (56.7%, CI=44.1-68.4) when compared with those living in Bolifamba (24.2%, CI=15.3-36.2) and Mutengene (22%, CI=16.7-28.5). The highest incidence of anaemia was recorded among pupils in the middle class (53.6%, CI=35.8–70.5) while the lowest was recorded among the poor (24.7%, CI=19.8-30.4). The difference in anaemia status between the socio-economic classes was statistically significant (χ^2=13.4, *P=0.001*) as shown in Table 3.

The maximum (17.4g/dl of blood) and minimum (6.5/dl) haemoglobin levels were recorded in children in the middle class. The mean haemoglobin concentration in the study population was 11.79g/dl. The mean haemoglobin level varied significantly with malaria parasite status, social class and study site. Pupils who were malaria parasite positive, belonged to the middle class and lived in Dibanda, recorded the lowest mean Hb levels than their counterparts as shown in Table 3.

3.4 Influence of Environmental Factors on Malaria Parasite Incidence and Anaemia

Although not statistically significant (*P*>0.05), the incidence of malaria parasites was higher in pupils who had bushes (43.6%, CI=34.7–53), with estimated population odds (EPO) of 0.8(CI=0.5-1.1), stagnant water around their homes (44.3%, CI=35.3-53.8) with EPO=0.8(CI=0.5-1.2) and lived in wooden houses (45.2%, CI=36.4-54.3) with EPO=0.8(CI=0.6-1.2) than those without bushes (42.4%, 35.8-49.4) with EPO=0.7(CI=0.6-1.0) or stagnant water around their homes (43.1%, CI=36.4–50) with EPO=0.8(CI=0.6-1.0) and those who lived in block houses (42.0%, CI=35.2-49.0) with EPO=0.8(CI=0.5-1.0) as shown in Fig. 1.

The incidence of anaemia was significantly higher (χ^2=5.8, *P=0.02*) in children who had bushes around their homes (37.0%, CI=28.5-46.4) with EPO=0.6(CI=0.4-0.9) than those who did not (24%, CI=18.5–30.5) with EPO=0.3 (CI=0.2-0.4). Although not statistically significant (*P>0.05*), anaemia incidence was higher in pupils who had stagnant water around their homes (29.8%, CI=21.9-39.2) with EPO=0.4(CI=0.2-0.4) and lived in wooden houses

(33.0%, CI=25.0-42.2) with EPO=0.4(CI=0.3-0.5) when compared with those without stagnant water around their homes (28.1%, CI=22.2-34.7) with EPO=0.4(CI=0.3-0.5) and lived in plank houses (26.1%, CI=25.0-42.2) with EPO=0.4(CI=0.3-0.5) as shown in Fig. 2.

Table 3. Incidence of anaemia and mean of Hb concentration in relation to sex, age, malaria, fever status, social class and site

Factor	Category	N	Incidence of anaemia % (N)	χ^2 P-Value	Hb conc. Mean (SD)	Range	Level of significance
Sex	Male	159	32.7(52)	1.9,	11.62(1.6)	7.1-17.4	t =-0.17,
	Female	149	25.5(38)	0.17	11.9(1.4)	6.5-15.9	*P=0.09*
Age	0-5	59	30.5(18)	0.94,	12(1.7)	8.4-15.9	F=1.2
(Years)	6-10	193	27.5(53)	0.63	11.7(1.4)	6.5-15.5	*P=.30*
	10-15	56	33.9(19)		12(2)	7.2-17.4	
Malaria	Positive	162	36.4(47)	5.6	11.5(1.7)	7.1-15.5	t=1.8
Status	Negative	146	33.3(43)	0.02	12(1.6)	6.5-17.4	*P=0.02*
Fever	Yes	78	20.5(16)	3.8	12(1.6)	7.2-17.4	t=1.36
status	No	230	32.2(74)	0.05	11.7(1.6)	7.5-15.9	*P=0.17*
Social	Poor	255	24.7(63)	2.67,	11.9(1.5)	7.2-15.9	*χ^2=13.4,
Class	Middle Class	28	53.6(15)	0.002	10.9(2.1)	6.5-17.4	*P=0.001*
	Rich	18	44.4(8)		11.4(1.7)	8.5-15.1	
Site	Bolifamba	62	24.2(15)	27.24,	11.9(1.5)	8.3-17.4	F=21.2
	Dibanda	60	56.7(34)	0.001	10.6(1.4)	6.5-13.3	*P<0.001*
	Mutengene	186	22(41)		12.1(1.5)	7.2-15.9	
Overall		308	29.8(90)		11.9(1.6)	6.5–17.4	

**Kruskal Wallis test*

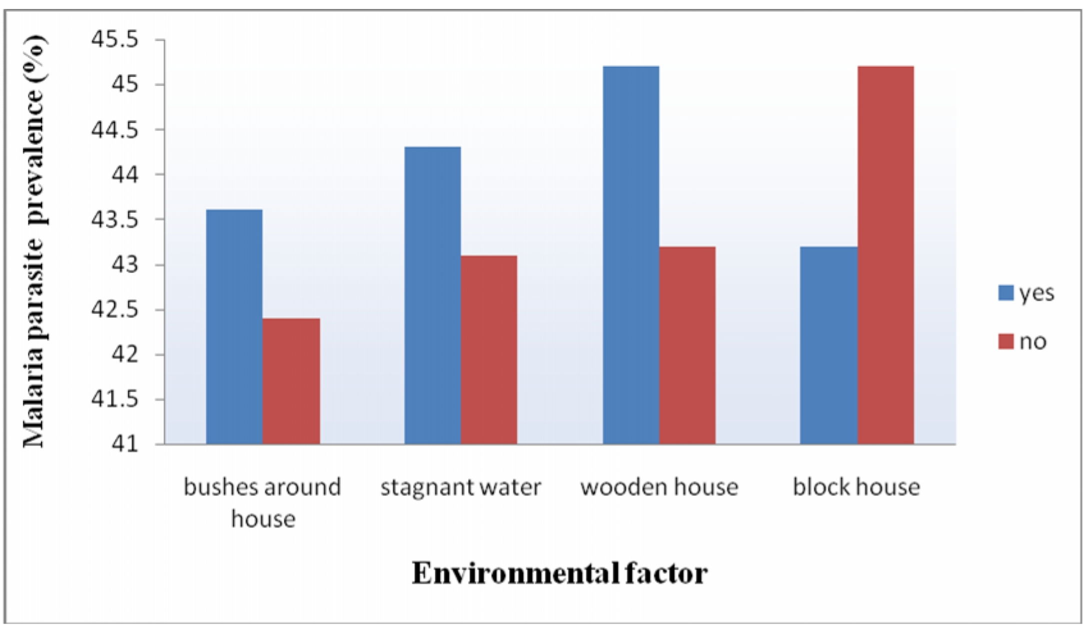

Fig. 1. Incidence of malaria according to environmental factors

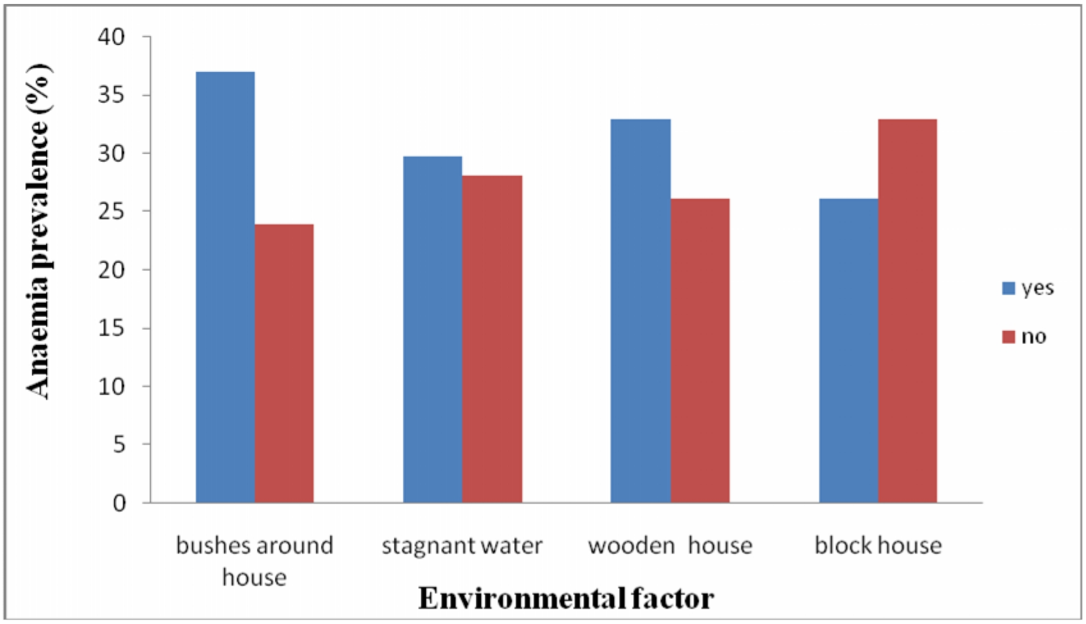

Fig. 2. Incidence of anaemia as affected by environmental factors

4. DISCUSSION

This study revealed that malaria was a major public health problem but its incidence can be reduced by application of appropriate control measures [11]. Malaria incidence varies with age sex and socio-economic factors of the population. The incidence of asymptomatic malaria in this study (43.4%) is lower than that reported by other workers [10,11,12,15] in and around the Mount Cameroon region. This drop in incidence can be compared with those reported in other parts of Africa such as Kenya [16] and Tanzania [17]. The drop in incidence could be attributed to increased government interventions such as free malaria screening and treatment in Cameroon for all children 0–5years and the efficient supply of atemisinin-based combination therapies for malaria [6]. This free treatment is available in public and privately owned hospitals, clinics and health centres which are at the base of the community. Also subsidization of the prices of anti-malarial drugs as found in the pro-pharmacies in Cameroon has made treatment more affordable to the people [18]. The creation of health centres in most villages and localities by the Ministry of Public Health has also brought medical intervention closer to the people. Worthy of note is the nationwide free distribution of insecticide-treated bed nets (ITNs) as well as long lasting insecticide nets (LLINs) for households and the sensitization on radio and television (information campaign) appears to be yielding positive results [18]. Initially, this gesture was directed only at the groups at risk of malaria such as pregnant women and children under five, but since 2009, it has been extended to every household especially in the urban and semi-urban areas.

The highest incidence of malaria (49.0%) among pupils in the 6-10 years age group could be the result of lack of finances to access proper health care and the effect of self-medication. Since these pupils are no longer in the age group that receives free treatment for malaria their parents sometimes are unable to afford the medication hence, resort to self-medication. Nkuo-Akenji and her co-workers reported that some parents administer treatment at home which they discontinue once the symptoms of fever disappear or only seek medical attention when fever persists [19]. However, some parasites (dormant stages) may still be found in blood even after the disappearance of fever [20] which will lead to asymptomatic malaria.

Furthermore, children in this age group also play outdoors more often than those in the age group 0-5 years exposing themselves to more mosquito bites. This falls in line with the report of Maxwell [21] who indicated that fewer mosquito bites implies fewer inoculations and also fewer malaria disease episodes.

Children in the age group 10-15 years had the lowest prevalence of malaria probably because these children have developed some immunity with age [21]. Children in high malaria transmission areas are continuously exposed to infection and quickly acquire and maintain protective immunity against severe disease so that during subsequent episodes, they tend to suffer less severe forms of uncomplicated malaria [22]. In addition, children above 10 years are more knowledgeable than those below 10 years and can undertake personal protective measures such as wearing of dresses and socks that cover the body and reduce the risk of mosquito bites. Such children can undertake physical killing of mosquitoes that could bite and if infected, transmit the malaria parasite.

Furthermore, it was reported that more males were positive for malaria than females [6,14]. This may be due to the fact that male children tend to play outdoors without shirts (wearing only trousers) than female children. The exposure of the bare uncovered and unprotected body increases the risk of mosquito bites and increases the risk of infection with malaria parasites.

The highest prevalence of malaria observed in children living in Bolifamba may be the result of a crowded neighbourhood where houses are constructed in close proximity to one another. Mosquitoes therefore fly for shorter distances to get to the next host thereby increasing transmission rate and thus malaria prevalence. Also, in a crowded neighbourhood, transmission and prevalence will be high because mosquitoes prefer human blood to animal blood [23,24]. The close proximity of houses is an indication that more humans are found within a small geographical area. As such during intermittent feeding by mosquitoes, they can feed on several persons in one night and if the parasite is present, it will be transmitted to several people in one night. Furthermore, some parts of Bolifamba are characterised by mashy land (“lamba”), poor drainage system with stagnant pools which are good breeding grounds for the different species of *Anopheles* vectors as postulated by Shilulu [25].

Although not significant the prevalence of malaria parasites was higher in pupils with fever than in those without fever. This attests to the fact that fever is a prominent sign of malaria although it is also a sign of many other diseases such as bacterial and viral infections as well as worm infestation The difference in prevalence of anaemia between those who had fever and those who did not have approached significance. The length of fever in days has been reported to be a risk factor of anaemia [12].

The age group 10-15 years had the highest prevalence of anaemia (33.9%) and this did not correspond to the age group with the highest malaria prevalence (6-10 years). In some children, repeated untreated or inadequately treated attacks of otherwise uncomplicated malaria might result in progressive anaemia [26] such as that between the ages of 10-15 years.

The significantly highest prevalence of anaemia among inhabitants of Dibanda which is a rural area than in Bolifamba (semi-urban) and Mutengene (semi-urban) could be linked to poverty and malnutrition in the rural settings. Socio-economic status has been found to be significantly associated with the prevalence of anaemia [9] with lower prevalence attributed to higher socio-economic status. In addition, WHO [8] postulated that the prevalence of anaemia generally decrease as incomes rise.

It is well known that one of the main clinical features of malaria in an individual is a fall in haemoglobin (Hb), often resulting in anaemia [27]. Consistent with findings of Kimbi [11], the incidence of anaemia was significantly higher in malaria parasite positive pupils than the negative ones. Following the life cycle of the malaria parasite in the human host, meroziotes can live in blood and multiply in the blood cells of the patient leading to blood cell destruction and consequently anaemia. As the merozoites multiply and increase in number, they destroy more red blood cells increasing the severity of anaemia as time goes on if the disease is left untreated [21].

Although not significant, more males had anaemia than females. This may be a reflection of impact of the parasite on haemoglobin levels as malaria disease was higher in males than in females. Females were either more immune to malaria and anaemia than males or environmental and social factors probably had an effect on the sex-related anaemia. Also, males are more active than females, so the opportunity to get in contact with a source of malaria is higher.

Majority of the pupils examined belonged to the poor social class (74.75%) and malaria incidence was higher among the poor (45.2%) than the rich (22.2%). This observation agrees with the fact that most inhabitants of Sub-Saharan Africa are poor and malaria is a disease associated with poverty [28]. Anaemia incidence was highest among the middle class, closely followed by the rich and lastly by the poor class. These findings contradict the postulations of Common Wealth Ministers Update of 2009 [29] , which stated that high levels of poverty in most African countries and reliance on subsistence farming by the majority of the population increase vulnerability to climate change and lead to increase in disease prevalence [29]. The finding in this study also contradicts the postulations of WHO [8] stating that anaemia generally decreases as incomes rise. The low anaemia incidence observed could be as a result of the fact that the poor people in this area cultivate different varieties of vegetables which they consume and sell. In fact many families in the study area depend on the sale of fruits and locally cultivated vegetables.

The incidence of malaria was higher among those who had stagnant water (43.6%) and bushes (37.0%) around their homes. According to WHO [30], each vector species inter-relates with its environment to be able to survive and in doing so transmit disease. The presence of stagnant water bodies around human habitation serves as breeding and survival sites for mosquito larvae while the bushes serve as resting sites for mosquitoes. As stated by Schmidt and Larry [21] adult mosquitoes rest during the day under leaves, in cracks and holes in tree trunks and only emerge at night to feed. The combination of water and bushes around houses could lead to increase in malaria burden because water is an essential component of the mosquito's environment. Considering that the study sites have mostly fresh water bodies, with the most important vectors of human malaria; *An. gambiae sensu stricto and An. arabiensis* being fresh water breeders and have the broadest geographic distribution [31] these species are most likely to be abundant and malaria transmission and prevalence is most likely to be high.

Even though not significant it is worth noting that the difference in incidence of malaria in relation to house type was high in an era where mosquito nets have been freely distributed to the population. The low and ineffective utilization of the mosquito bed nets could have exacerbated the impact of the house type. However, most wooden houses in Cameroon have tiny holes between the sheets of wood and lack ceiling. As such tactile stimuli emanating from the host skin can easily be perceived outdoors. The strength of the host derived stimuli compared to other competing external stimuli such as odours from other sources (e.g. flowers) which in turn depend on wind speed and wind direction and proximity of potential host to mosquito vector [32] attract the mosquitoes to feed on the host. The response to these stimuli brings the mosquito close to additional stimuli such as visual cues, convection current and other volatile and tactile chemicals. This induces the mosquito to penetrate through the tiny holes, land on the potential host and take a blood meal. If the house is close to a breeding site, the mosquitoes may obtain their blood without having to fly for long distances. However, strong winds can help to disperse them as far as 30km away from their breeding sites [33].

The significantly higher incidence of anaemia in children who had bushes around their homes, could be linked to the impact of malaria transmission. Similarly, although not significant the prevalence of anaemia followed the same trend as incidence of malaria in those with stagnant water around their houses, lived in block and plank houses.

5. CONCLUSION

From this study, it was concluded that the incidence values of malaria and anaemia in Fako Division are associated with socio-demographic and environmental factors. Sensitization on effective mosquito bed net utilization therefore needs to be emphasised as well as other personal and environmental control methods so that reduction in malaria burden can be effected. Combined efforts of the government and individuals can help to reduce malaria and anaemia by reducing poverty levels and keeping mosquito-free environments.

CONSENT

All pupils were issued consent forms to seek for their parents’ approval. Pupils were accepted for screening when they brought back signed informed consent forms following the approval of their parents.

ETHICAL CONSIDERATION

An ethical clearance was obtained from the South West Regional Delegation of Public Health. Administrative clearances were obtained from the Regional Delegation of Basic Education as well as from The Catholic Education Board.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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