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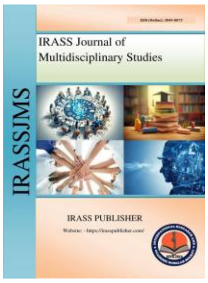

Prevalence and Associated Risk Factors of Malaria and Anemia in Children Aged 0-12 Years Attending the Nkwen District Hospital Bamenda Cameroon

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Abstract:

Background: Malaria is a mosquito-borne infectious disease that affects humans and other animals. The most serious and sometimes fatal type of malaria is caused by Plasmodium falciparum. The other human malaria species, P. vivax, P. ovale, P. malariae, and sometimes P. knowlesi can cause acute, severe illness but mortality rates are low. A signifcant proportion of these deaths resulted directly or indirectly from anemia. Anemia defined as a low blood hemoglobin concentration, has been shown to be a public health problem. The prevalence of malaria and anemia is associated with Parents' age, education level and who they live with as well as where they live.

Objectives: The general objective of this research is on the prevalence of malaria and anemia and the associated risk factors in children aged 0-12years

Methods: This was a hospital based cross sectional study in the Nkwen District Hospital Bamenda where questionnaires were administered to collect information for social demographic and risk factors of malaria and anemia. Malaria tests was done microscopically staining with giemsa and anemia evaluated by was done using a hemoglobinometer to get the hemoglobin range

Results: The total prevalence of malaria, anemia and malaria with anemia was 15.5%, 44% and 11.5% respectively. Our study also reveal some associated risk factors of malaria, anemia and malaria with anemia face by children from 0 to 12years such as sex, age of child and parents, single parent, and some other instrisic factors like use of ITNs, outdoor sleeping, use of insecticide and the transfusion history.

Conclusion: this study revealed that malaria and anaemia constitute public health problems in the area with anemia being a severe public health concern while malaria is a mild public health issue in children attending the Nkwen District Hospital . Parents' age, level of education, where they live was directly linked to malaria and all anaemia forms as well as risk factors like ITNs, mosquito insecticides, stagnant water in the environment and outdoor sleeping. Hence measures should be put in place in order to reduce the prevalence of malaria and anemia amongst children and it is important to conduct further investigations to identify the underlying causes of anemia in children.

Keywords: Prevalence, Malaria, Anemia, Nkwen District Hospital.

1.0 Introduction

1.1 Background knowledge

Humans and other animals can contract malaria, an infectious disease spread by mosquitoes [1]. Only female Anopheles mosquitoes carrying the infection can transmit it through bites. The parasites from the mosquito's saliva enter a person's bloodstream through a mosquito bite. [1] After maturing and procreating in the liver, the parasites are discharged into the bloodstream to infect the red blood cells [2]. Plasmodium protozoan parasites are the cause of malaria. Plasmodium falciparum is the causative agent of the most severe and occasionally lethal form of malaria. Although the fatality rates are modest, the other human malaria species—P. vivax, P. ovale, P. malariae, and occasionally P. knowlesi—can cause acute, severe disease. With over 40% of the world's population at risk for malaria in almost 100 nations, malaria is the most prevalent infectious illness in tropical and subtropical climates and remains a serious global health concern. Over 500 million people are thought to contract malaria each year, which leads to 1-2 million fatalities, 90% of which are in sub-Saharan Africa [2]. Due to rising transmission risk in regions where malaria control has decreased, the rise in drug-resistant parasite strains, and in a small number of cases, significant increases in international travel and migration, the number of malaria cases globally appears to be rising [2].In Africa, rural regions are more likely to transmit malaria than urban areas (3,4). The reported lower prevalence of malaria in urban settings can be attributed to a number of factors, including higher human density, lower vector density, better and quality housing, enhanced drainage systems, and relative ease of evaluating healthcare facilities in urban regions (4,6). Since an accurate diagnosis lowers malarial complications and death, there is a growing demand for practical and efficient diagnostics for worldwide malaria control [1]. According to estimates from the World Health Organization (WHO), there were approximately 445,000 malaria-related fatalities and 216 million cases in 2016 [7]. However, malaria continues to be a leading cause of death for children, with an estimated kid dying from it every two minutes [8].

Childhood mortality is still too high even with improved knowledge of the etiology and treatment of malaria [9]. Anemia was the direct or indirect cause of a significant percentage of these deaths [10]. Additionally, severe anemia has been linked to more than half of malaria-related mortality [11].It has been demonstrated that anemia is a public health issue that hits low-, middle-, and high-income nations. It has serious negative effects on social and economic development in addition to having detrimental health effects. Globally, anemia remains a serious public health issue. The World Health Organization estimates that two billion people worldwide suffer from anemia [12]. Anemia is most common in the developing world, where its causes are diverse and include viral disorders like malaria and worm infections as well as nutritional deficiencies including iron, folate, and vitamin B12 [13]. Iron deficiency anemia is the most prevalent type of anemia in underdeveloped nations and is estimated to impact the health of over a billion people globally [14]. The majority of anemia cases brought on by parasite infections are caused by iron deficiency anemia. In less developed nations, women and small children are more severely impacted [15]. The amount of iron needed varies depending on the stage of life. It is extremely high in children, preterm newborns, low birth weight babies, and pregnant women, when an additional iron supply may be required [16]. According to recent studies, children who are iron deficient have significant consequences, such as poorer learning and behavioral skills, a decreased capacity for hard labor, and poor appetite and growth [14]. Iron deficiency is thought to be the cause of about 50% of anemia cases, while the percentage likely changes depending on local conditions and among demographic groups. Iron and malaria have a complicated but significant association. Iron is necessary for Plasmodium proliferation throughout both the disease-associated phase of erythrocyte infection and the clinically silent liver stage of growth. Iron chelators can prevent pathogen growth in vitro and in animals, however it is still unknown how exactly the protozoan obtains its iron from its mammalian host [15]. In these regions, anemia—which primarily affects young children—is the primary sign of severe malaria. Malaria is one of the most frequent causes of blood transfusions in regions with greater transmission rates and a major cause of anemia in endemic areas. Anemia is a moderate to severe public health issue that significantly increases morbidity and death in practically every Sub-Saharan African nation [16]. A condition known as anemia, which can differ from person to person and from gender to gender, is characterized by a lack of hemoglobin in the body. Men with anemia have hemoglobin concentrations below 13 g/dl, young girls over 15 years old have hemoglobin concentrations below 12 g/dl, and children have hemoglobin concentrations below 11.0 g/dL [17]. People may have mild, moderate, or severe symptoms. At an acute state, it is severe and potentially lethal, but it is treatable at an early stage. In Sub-Saharan Africa, childhood anemia is regarded as a serious public health issue (62.5%), and in Cameroon specifically, where a prevalence of 63.2% was recorded in 2011 [8].

Following an infectious mosquito bite, the malaria parasites enter the bloodstream and infect red blood cells. Red blood cells burst at the end of that infectious cycle. Red blood cell counts are decreased by this process, which can lead to severe anemia in its latter stages. The coexistence of anemia and malaria is observed in humans in the malaria endemic zone because certain anemias, such as sickle cell anemia and iron deficiency anemia, can protect against malaria. Additionally, the measures taken to reduce malaria also reduce anemia, and a decrease in malaria control methods increases anemia in the population.

1.2 Statement of the problem

Malaria is still one of the most significant parasite diseases affecting humans, despite numerous studies and investigations being conducted to prevent and slow its spread [1]. According to estimates from the World Health Organization (WHO), there were approximately 216 million cases of malaria and 445,000 fatalities from the disease in 2016; a significant percentage of these deaths were caused directly or indirectly by anemia [10]. Conversely, anemia is a worldwide health issue that is especially common in developing nations. Anemia is a moderate to severe public health issue that causes major morbidity and mortality, primarily in children, in 50 percent of Asian nations and 49 percent of Sub-Saharan African countries [16]. Iron deficiency is one of the numerous causes of anemia, which is characterized by a low blood hemoglobin concentration. Malaria is a prominent cause of anemia at the population level in places where the disease is widespread. According to the authors, malaria is responsible for 24.7% of anemia in sub-Saharan Africa [16], with children accounting for a large share of this. Anemia accounts for the majority of malaria-related deaths, and as children's immune systems are still developing, they are particularly vulnerable. For this reason, it is crucial to look into the prevalence of malaria and anemia in this population as well as the risk factors that are linked to it.

1.3 Research question

- what is the prevalence of malaria, anemia and malaria with anemia in children?
- what are the risk factors of malaria and anemia in children?

1.4 Hypothesis

Hypothesis 1

H0: There are risk factors associated with malaria and anemia in children.

H1: There are no risk factors associated with malaria and anemia in children.

Hypothesis 2

H0: Malaria can lead to anemia in children

H1: Malaria cannot lead to anemia in children

1.5 Objectives

1.5.1 Main objectives

Chapter two of my research proposal, PREVALENCE AND ASSOCIATED RISK FACTORS OF MALARIA AND ANEMIA IN CHILDREN AGE 0-12 YEARS ATTENDING THE NKWEN DISTRICT HOSPITAL BAMENDA, will be developed with the help of this study's general goal, which is to examine malaria and anemia in children and the risk factors that are associated with them.

1.5.2 Specific objectives

- To investigate the prevalence of malaria, anemia and malaria with anemia in children aged 0-12years.
- To assess the associated risk factor with malaria, anemia and malaria with anemia in children aged 0-12years.

1.6 Rationale

Malaria is a parasitic infection faced by many people especially children and can lead to severe and acute complications in children. Malaria can easily infect children associated with certain risk factors like living in malaria endemic areas, no use of Insecticide treated Nets, an area with stagnant water and sleeping outdoor. Anemia known as low blood hemoglobin concentration in the body is also a condition which affects children. Anemia can easily affect children with associated risk factors like malnutrition and parasitic infections Malaria is a major cause of anemia in endemic areas. Severe malaria can lead to anemia causing morbidity and mortality mostly in children. So this project is aimed at assessing the prevalence and associated risk factors of malaria, anemia and malaria with anemia in children aged 0-12 years attending the Nkwen District Hospital Bamenda.

1.7 Significance of the study

To the participants : This study will help to evaluate the prevalence and associated risk factors of malaria and anemia in children which will serve as a guide for children to know more about this health condition and how it can be prevented.

To the school: It will serve as a source of preliminary data for any research that may be carried out on any topic similar to this.

To the government: This study will provide more information that may guide future intervention and guidelines towards the prevention of malaria and anemia in children which is a global health problem.

2.0 Literature Review

2.1 Epidemiology of malaria

With up to 500 million febrile cases and up to 1 million fatalities annually, malaria is one of the world's main causes of illness and mortality [19, 20, 21]. P falciparum is the most deadly, causing almost all malaria-related deaths in the US and around the world. The severity of malaria transmission affects the disease's clinical outcomes, particularly the incidence of anemia. The density, duration, biting patterns, and effectiveness of the local mosquito vectors are the primary factors that determine the intensity of malaria transmission [19]. Young children are the ones that suffer the most from the disease, but in high transmission environments, individuals may get up to one infectious bite every day, meaning that the entire population is infected frequently. By adolescence and maturity, almost all malaria infections are asymptomatic due to the development of a disease that controls immunity as the kid matures. Anemia's prevalence decreases. Therefore, malaria parasites are present in the blood of people who appear to be in good condition. Therefore, malaria raises the risk of anemia in all populations in greater transmission environments, with small children being most affected [22]. All ages may get symptomatic malaria and the ensuing anemia in lower transmission settings, however children are particularly susceptible. Malaria is a major cause of maternal anemia during pregnancy and unfavorable birth outcomes at all transmission levels [27].

2.2 Overview of malaria

A parasite that typically infects female Anopheles mosquitoes that feed on humans causes malaria, a dangerous and occasionally lethal illness. People who contract malaria usually have flu-like symptoms, high fevers, and chills. Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae are the four types of malaria parasites that infect humans. Furthermore, P. knowlesi, a kind of malaria that normally affects macaques in Southeast Asia, can infect humans as well, resulting in zoonotic malaria, or malaria that is spread from animal to human. The kind of malaria that is most prone to cause serious infections and, if left untreated, can be fatal is P. falciparum. Malaria can be fatal, yet it is usually preventable in terms of illness and mortality.

2.3 symptoms of malaria

Symptoms of malaria may appear as soon as 6–8 days following a mosquito bite or as long as several months after leaving a malarial region. Fever, chills, coughing, respiratory distress, joint pain, headache, watery diarrhea, vomiting, and convulsions are common symptoms of malaria parasite infections. Severe malaria is typically complicated, and a number of important pathogenic processes, including severe anemia, kidney failure, and jaundice, can come together to generate a devastating and frequently fatal illness.

2.4 Mode Of Malaria Transmission

- Can be transmitted by the bite of a female anopheles mosquito
- transfusion of blood from infected persons
- use of contaminated syringes and needles
- congenital transmission (infected mother to child during delivery)

2.5 Transmission And Life Cycle

This takes place in two ways; Asexual life cycle which takes place in humans while sexual life cycle takes place in mosquitoes.

2.5.1 Life cycle in humans

The asexual life cycle in humans is in two stages the pre-erythrocytic and erythrocytic stages

2.5.1.1 In the liver or pre- erythrocytic cycle

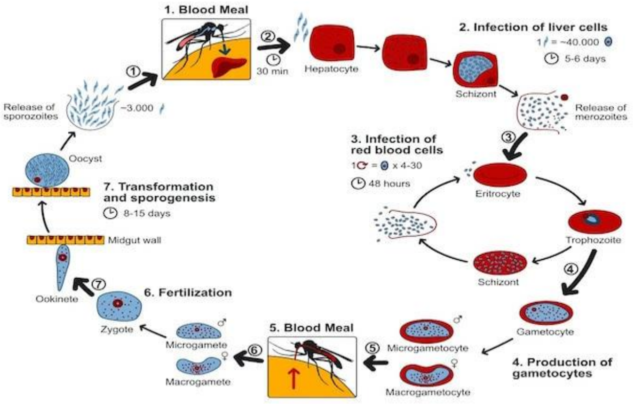
By entering the bloodstream, the motile sporozoite can make its way to the liver and avoid host immunity or lymphatic system drainage [28, 29]. After entering the liver sinusoids, sporozoites penetrate the sinusoidal barrier and enter the hepatocytes [28], where they differentiate in a first round of asexual replication [30] and form a parasitophorous vacuole. Depending on the species, a multinucleated exoerythrocytic schizont (or meront) with thousands of offspring merozoites forms over the period of two to three days. By developing a non-replicating hypnozoite rather than a schizont, several parasite species, including P. vivax and P. ovale, can thereafter undergo a period of latency. Relapses may result from these hypnozoites, which allow the parasite to survive for a long time. Merozoites are discharged back into the bloodstream through the liver sinusoids after exiting the hepatocyte and clumped together in membrane-bound vesicles known as merosomes [31].

2.5.1.2 In the blood stream or erythrocytic life cycle

After merozoites infiltrate red blood cells (RBCs), a second asexual schizogony occurs. Over the course of 24 to 72 hours, this asexual replication cycle can produce up to 32 merozoites (these parameters vary between species). The parasite creates acute and ultimately chronic infections through recurrent rounds of invasion and development. Because reticulocytes only comprise a small portion of circulating red blood cells, certain species, including P. vivax, are limited in their ability to cause complete parasitaemia. Some, like P. falciparum, are not constrained and can infect a significant percentage of red blood cells, resulting in a high parasite burden, which is linked to P. falciparum's ability to cause serious illness. A portion of the contaminated blood cells exit the asexual multiplication cycle. The merozoites in these cells do not reproduce; instead, they mature into gametocytes, which are sexual forms of the parasite that move through the bloodstream.

2.5.2 Life cycle in mosquitoes

During a blood meal, an Anopheles mosquito consumes the gametocytes—male (microgametocytes) and female (macrogametocytes). The sporogonic cycle is the process by which parasites multiply in mosquitoes. The microgametes in the mosquito's stomach break through the macrogametes to produce zygotes. The zygotes then develop into elongated, motile ookinetes, which infiltrate the mosquito's midgut wall and mature into oocysts. Sporozites are released when the oocysts develop, burst, and travel to the mosquito's salivary glands. The malaria life cycle is perpetuated when the sporozoites are injected into a new human host.



2.6 Pathophysiology of malaria

Since malaria is an intraerythrocytic parasite, red blood cells that contain the parasite must be destroyed when the schizont ruptures. In falciparum malaria, parasitemia typically exceeds 1% (of parasitized red cells), and in cases of severe illness, it can surpass 10%. Although parasite concentrations in the other human malarias hardly ever above 2%, Plasmodium knowlesi can also result in hyperparasitemia [32]. Anemia quickly develops and there is a high parasite burden in cases of severe falciparum malaria. Hemolysis of unparasitized red blood cells is the primary cause of this often quick drop in hematocrit [26, 33–35]. Compared to P. falciparum infections, the ratio of unparasitized red blood cells to parasitized red blood cells lost in acute malaria is considerably larger in P. vivax infections [34]. During and immediately following the acute infection, bone marrow dyserythropoiesis exacerbates the hemolytic anemia caused by malaria [42,43].

2.7 Malaria Prevention Methods And Associated Risk Factors

2.7.1 Use of insecticide treated nets(ITNs)

Compared to children who reported using ITNs, those who reported not sleeping beneath them are more susceptible to malaria. The chemical in it repels or kills mosquitoes, so it protects people at least physically.

2.7.2 Use of mosquito insecticides

According to other research, using mosquito control methods such aerosol sprays, herbs, and mosquito coils is linked to a decreased chance of developing clinical malaria. It has been utilized frequently in pest management and public health initiatives, notably as a last resort during malaria outbreaks.

2.7.3 Stagnant water

Participants in the study were protected against malaria by the lack of standing water near their homes. This result is consistent with other research findings. This might be explained by the fact that Anopheles mosquitoes may reproduce in stagnant water. Consequently, having this kind of water near the house may attract more mosquitoes and aid in the spread of malaria. Some infection-prevention strategies target the mosquito vector in either its larval or adult phases. Eliminating breeding grounds, such as by filling ditches and draining them, is one of the primary strategies for managing larvae. The surfaces of stagnant water can also be treated with petroleum oil or larvicides.

2.7.4 Outdoor sleeping

Numerous studies have found a link between sleeping outside and an increased risk of malaria. Potential causes include sleeping outside and engaging in various social, cultural, and commercial activities that enhance the risk of contracting infectious mosquito bites at night.

2.7.5 Educational knowledge on malaria

The effectiveness of school-based health education in maintaining and disseminating health information to communities has long been recognized. An alternative to raising children's awareness and knowledge of malaria prevention and encouraging their peers to use ITNs is to empower them and their guardians through a community-based education strategy.

2.8 Complications Of *P Falciparum*

- Anemia; the destruction of red blood cells by the malaria parasite can cause severe anemia.
- Cerebral malaria; in rare cases it can damage the brain by causing it to swell which can sometimes lead to permanent brain damage and seizures.
- liver failure and jaundice ;yellowing of the skin and whites of the eyes
- shock – a sudden drop in blood pressure
- pulmonary oedema; a build-up of fluid in the lungs
- acute respiratory distress syndrome (ARDS)
- kidney failure
- swelling and rupturing of the spleen
- Dehydration

2.9 Treatment of malaria

The most common antimalarial drugs include:

- Artemisinin-based combination therapies (ACTs). ACT is a combination of two or more drugs that work against the malaria parasite in different ways. Examples include artemether-lumefantrine (Coartem) and artesunate-amodiaquine(Camoquin).

Other common antimalarial drugs include:

- Atovaquone-proguanil (Malarone)
- Dihydroartemisinine-piperaquine

2.10 An overview of anemia

When you don't have enough healthy red blood cells to deliver enough oxygen to your body's tissues, you have anemia. You may feel weak and exhausted if you have anemia, commonly known as low hemoglobin.

2.11 Different types of anemia

2.11.1 Sickle cell anemia

One of the hereditary conditions referred to as sickle cell disease is sickle cell anemia. Red blood cells, which transport oxygen to every region of the body, are impacted by it. A mutation in the gene that instructs the body to produce hemoglobin, an iron-rich substance found in red blood cells, results in sickle cell anemia. Red blood cells may transport oxygen from the lungs throughout the body thanks to hemoglobin. The hemoglobin linked to sickle cell anemia results in stiff, sticky, and malformed red blood cells.

2.11.2 Iron deficiency anemia

A blood condition called iron deficiency anemia alters the condition of your red blood cells. Blood loss, reduced absorption, or inadequate iron intake can all lead to iron insufficiency. The most common cause of iron-deficiency anemia, particularly in elderly people, is blood loss. Low food intake, elevated systemic iron requirements (like during pregnancy), and impaired iron absorption (such in celiac disease) can also cause it.

2.11.3 Vitamin B12 deficiency anemia:

The body needs vitamin B12 to form healthy red blood cells, when a child doesn't get enough vitamin B12 from their diet, their body can't produce enough healthy red blood cells.

2.11.4 Folate deficiency anemia

The absence of folic acid in the blood is known as folate deficiency anemia. One B vitamin that aids in the production of red blood cells is folic acid. It is typically brought on by a diet deficient in folic acid. Folic acid is found naturally in leafy vegetables, citrus fruits, legumes, and whole grains.

2.11.5 Aplastic anemia

The disorder known as aplastic anemia occurs when the bone marrow is unable to produce enough new blood cells. Cancer or an infection may be the cause of this.

2.11.6 Hemolytic anemia

A condition known as hemolytic anemia occurs when the body breaks down red blood cells more quickly than they can be produced. Hemolysis is the breakdown of red blood cells.

2.11.7 Thalassemia

This is a genetic hemolytic illness brought on by a defective hemoglobin and a lower-than-normal number of red blood cells.

2.12 Diagnostic methods in anemia

2.12.1 **Complete blood count (CBC).**

The amount of blood cells in a sample of your blood is determined by a complete blood count (CBC). CBC can give a lot of information and can identify a number of distinct characteristics. The presence or absence of anemia in a patient is determined by hematologic and biochemical changes in red blood cells. MCV is likely to offer hints on the cause of anemia if it is present.Your doctor will probably want to know how much hemoglobin and red blood cells (hematocrit) are in your blood if you have anemia. In general, healthy adult hematocrit ranges are 35.5% to 44.9% for women, 38.3% to 48.6% for men, and 35 to 44% for children. Men's healthy hemoglobin levels range from 13.0 to 16.6 g/dL, women's from 12.0 to 15 g/dL, and children's from 11.0 to 14.5 g/dL. Each medical practice may have slightly different values.

2.12.2 Bone marrow tests

A bone marrow test determines whether your bone marrow is healthy and producing enough blood cells. Aspiration and biopsy are two bone marrow tests that are frequently performed simultaneously.

2.12.3 Reticulocyte count

The quantity of immature red blood cells in the blood is determined by this test. Because bone marrow produces these cells, a high reticulocyte count may indicate that blood loss is the cause of your anemic symptoms. Additionally, it is crucial for the diagnosis of hemolytic anemia.

2.12.4 Iron panel

When anemia is thought to be caused by an iron deficiency, this is done. A blood test that gauges the amount of iron in the blood is called an iron panel.

2.12.5 A test to determine the size and shape of your red blood cells.

Additionally, some of your red blood cells may be analyzed for abnormalities in size, shape, and color.

Here, a blood smear is performed to look for anomalies in the platelets, white blood cells, and red blood cells.

2.13 Causes of anemia

Anemia frequently indicates another illness. The following conditions frequently result in anemia: iron, vitamin B12, and folate deficiencies, Some medications, premature destruction of red blood cells, Long-term (chronic) illnesses such rheumatoid arthritis, ulcerative colitis, cancer, and chronic renal disease, bone marrow disorders like aplastic anemia, multiple myeloma, leukemia, or lymphoma, Insufficient production of red blood cells specific infections, Inadequate nourishment

2.14 Symptoms of anemia

The origin and severity of anemia determine the signs and symptoms. You may not have any symptoms at all, depending on the source of your anemia.

If symptoms do appear, they could include:

Weakness, Fatigue, yellowish or pale skin, irregular heartbeats, dyspnea, lightheadedness or dizziness, discomfort in the chest, chilly feet and hands, A headache

2.15 Anemia prevention methods and associated risk factors in children

2.15.1 Anemia due to parasitic infections

Schoolchildren are more likely to contract some parasitic illnesses, including soil-transmitted helminths and protozoan parasites, which feed on the blood of the host tissue and cause iron and protein loss, which results in anemia. In terms of the child's malaria status, it was discovered that children with malaria were more likely to experience anemia than their peers without the disease.

2.15.2 Malnourishment

As an adaptive reaction to their low nutritional intake, malnourished children have a lower metabolism. Because of the slowed metabolism, there is a lower need for oxygen and less formation of red blood cells, which leads to adaptive anemia. Children who consume insufficient amounts of nutrients necessary for growth and hemoglobin synthesis may be at risk of developing both anemia and malnutrition at the same time. Iron is the most crucial micronutrient for hemoglobin production, and children who are calorie-deficient are more likely to be lacking in other micronutrients as well. Children who are malnourished have weakened immune systems, making them more vulnerable to infection. Anemia has been linked to the infection's subsequent effects, which include blood loss, immune-mediated destruction of red blood cells, malabsorption, underutilization of bioavailable minerals like iron, and nutritional loss. Anemia is still linked to a lack of consumption of iron-rich foods, which highlights the significance of proper family nutrition. Children were better protected against anemia if their parents reported eating these items at home.

2.15.3 Mother's educational level

Children were less likely to be anemic if their moms had completed secondary school or above. These findings were consistent with earlier research on the relationship between maternal education and children's anemia. Mothers with higher levels of education are more likely to be aware of healthy eating habits and to consider food's nutritional content. Additionally, they have a better understanding and give their kids a clean, healthy diet.

2.15.4 Older mothers

Younger mothers are less equipped to meet their children's nutritional demands and carry out the responsibilities of parenting, as seen by the risk of anemia in their offspring. This could be a result of inadequate funding, ignorance of anemia and child care, and a lack of proper direction.

2.16 Treatment of anemia

Treatment should be directed at the cause of the anemia, and may include:

- Blood transfusions.
- Corticosteroids or other medicines that suppress the immune system.
- Erythropoietin, a medicine that helps your bone marrow make more blood cells.
- Supplements of iron, vitamin B12, folic acid, or other vitamins and minerals.
- Bone marrow transplant mainly for aplastic anemia.

3.0 Materials and Methods

3.1 Study site

This study was carried out in the main laboratory of Nkwen District Hospital Bamenda. Bamenda is the chief town of north west region of Cameroon which is a cosmopolitan town whose inhabitants are engage in varied socio economic activities. The town has both government and private hospital taking over 350360 inhabitants and other villages around its locality as of 2011 demographic data. The Nkwen District Hospital PMI is strategically located in the heart of Nkwen in an environment that play host of Bamenda popular leisure spots. This hospital has its strength mostly in mother and child care. About 800 women frequent the hospital monthly on average for antennal care. The hospital also has other facilities used for consultation. All the department of the hospital are functioning 24/7 with health personnel available throughout. The hospital is headed by the General supervisor while the laboratory is headed by a laboratory head. It has different unit namely; reception, collection, serology, parasitology, microbiology and biochemistry.

3.2 Study Design

The research was a cross sectional study.

3.3 Study Duration

This study was conducted for a period of one month.

3.4 Study population

The study subjects were children aged 0-12 years who come to the hospital for either a malaria test or anemia tests or both.

3.5 Selection Criteria

3.5.1 Inclusion criteria

This study included all enrolled children whose parents were volunteers aged 0-12years,who are attending the Nkwen District Hospital Bamenda for their malaria or anemia tests.

3.5.2 Exclusion criteria

This study excluded;

- Non volunteer guidance of Children aged 0-12years who do not give their consent to participate in the study.
- Children aged 0-12years who come for other health challenges apart from malaria and anemia.
- Children aged 0-12 years whose parents didn't completely fill the questionnaires.

3.6 Size determination

The sample size was calculated using Cochran formula of 95% confidence interval and the subjects were chosen randomly. Cochran's formula is

n =z2 p(1-p)÷ d2

where n= required sample size

d= margin of error at 5% (standard value 0.05)

z= confidence level at 95% (standard value 1.96)

p= estimated prevalence 19.6% which is 0.196 [36]

therefore, n=(1.96)2X0.196(1-0.196) ÷(0.05)2

n=249

3.7 Laboratory procedure

3.7.1 Venous blood collection

- An EDTA anticoagulated tube was labeled with the child's initials ,age and date of collection.
- A suitable vein was choosed and the tourniquet was tied on the upper arm to enable veins to be seen and provide adequate pressure for blood flow.
- 70% of alcohol was placed on a cotton swab and used to cleanse the area to be punctured round the upper arm of the child, in order to decontaminate it.
- A 5ml syringe was used to collect the blood and it was transferred into the EDTA anticoagulated tube.
- -The child was asked to open her hand, the tourniquet was untied and a dry cotton was placed on the area before the syringe was withdrawn. The participant was asked to apply pressure on the puncture site until the blood stops flowing.
- The blood is then taken to the lab for examination.

3.7.2 Hemoglobin (HB) Measurement

The urit 12 strip was pulled out to its loading position and the display of the meter was activated by pressing down on the left button for about 10 seconds.

- The sample path of the urit 12 strip was filled with well mixed EDTA anticoagulated venous blood.
- After a few seconds, the hemoglobin value appeared on the urit 12 display screen, in g/dl.
- For Children who came for their Full blood count, the hemoglobin results were collected from the full blood count results.

3.7.3 Malaria

By staining a thick blood film on a glass slide, malaria parasites can be seen and the disease can be diagnosed under a microscope.

A syringe or vacuteiner is used to draw blood into an EDTA tube. A blood patch in the middle of the slide was agitated in a circular motion to create a thick blood film, being careful not to make the preparation too thick, and then left to dry without the use of fixative. Following drying, the area was stained for ten minutes using diluted Giemsa (1:20 vol/vol) and then rinsed under running water. The slide was examined under a light microscope with immersion oil after being left to air-dry vertically.

3.8 Data management

The data collected was coded and stored in printed sheets. The data will also be stored in a laptop, flash drives and in a smart phone. Storing the data in multiple devices will minimize the chances of losing the data.

3.9 Data collection

To gather data on sociodemographic traits and sociocultural risk factors, questionnaires were distributed.

3.10 Data analysis

The data for this study was analyzed using the statistical Package for social sciences (SPSS) for windows version 20.0.

3.11 Ethical consideration

The Institutional Review Board (IRB) of the University of Bamenda's Faculty of Health Sciences granted permission to conduct this study. After submitting a formal application, the Regional Delegate of Public Health sent an administrative clearance form. Every donor who participated in the study gave their informed consent. Opting out was an option for those who were no longer interested in taking part.

4.0 Results

Sociodemographic information of respondents

This study had 200 participants, of which there was a slight majority of males 105(52.5%) than females 85(47.5%). The highest age group of 138(69%) were within the range 0-4, of which majority 115(57.5%) lived >5 in a house. Majority of the parents 146(73%) were aged 19-35 and most 103(51.5%) had 2 children aged 0-12 years. According to who the live with, majority 132(62%) lived with their parents, with majority of the parents/guardians 87(43.5%) being at the tertiary level of education. There were more children in the urban area 194(97%) than the rural area.

Table 1: Sociodemographic information of respondents

Category	Sub-category	Frequency	Percent (%)
Gender	Male	105	52.5
	Female	95	47.5
Number of children	One child	68	34
	Two children	103	51.5
	Three children	25	12.5
	Four children	2	1
	Five children	2	1
Residence	Urban area	194	97
	Rural area	6	3
Who do you stay with?	Parents	132	66
	Mother only	46	23
	Father only	2	1
	Guardian	20	10
Education	Primary	14	7
	Secondary	86	43
	Tertiary	87	43.5
	I didn't go to school	13	6.5
Parents age	19-35	146	73
	36-52	45	22.5
	>52	9	4.5
Age group in years	0-4	138	69
	5 to 8	44	22
	9 to 12	18	9
Family size	2 to 3	32	16
	4 to 5	53	26.5
	>5	115	57.5

4.1 Prevalence of malaria, anemia and malaria with malaria.

4.1.1 Overall prevalence

Objective 1: To determine the prevalence of malaria, anaemia and malaria with anaemia in children aged 0-12years

Table 2: Prevalence of malaria, anaemia and malaria with anaemia in children aged 0-12years attending the Nkwen District Hospital Bamenda

Based on table 2, the prevalence of malaria, anemia and malaria with anemia are 15.5%, 44% and 11.5% respectively.

Category	Sub-category	Frequency (n=200)	Percent (%)
Malaria	Yes	31	15.5
	No	169	84.5
Anaemia	Yes	88	44
	No	112	56
Malaria with anaemia	Yes	23	11.5
	No	177	88.5
Levels of anaemia based on HB ranges	Severe anaemia	8	4
	Moderate anaemia	45	22.5
	Mild anaemia	35	17.5
	Non-anaemic	112	56

4.1.2 Prevalence of malaria according to the sociodermographic data

Table 3; The results of the Chi-Square test of association between sociodemographic variables and malarial status are presented in Table 3. Based on these findings, sex was found to be significantly (P-value < 0.01) associated with the malarial status of children aged 0-12 years attending the Nkwen District Hospital Bamenda at the 1% level of significance ($\alpha = 0.01$). Males (16.20%) were more likely to suffer from malaria than females (14.73%). Who the children stayed with was also significantly (P-value < 0.01) associated with their malarial status. Children who lived with their fathers only were most likely (100%) to suffer from malaria followed by children who lived with their mothers only (23.90%), children who lived with their parents (12.10%) and children who lived with their guardian (10.00%) in that order. All the other sociodemographic parameters were not significantly (P-value > 0.05) associated with children's malarial status at the 5% level of significance (α = 0.05).

Table 3: Chi-square test of association between sociodemographic variables and the malarial status of children aged 0-12years attending the Nkwen District Hospital Bamenda

Sociodemographic variables		**Malarial status**		**Chi square test summary**		
		Yes	**No**	X^2	**df**	**P-value**
Gender	**Male**	17 (16.20%)	88 (83.80%)	0.499	1	**0.999*** **
	Female	14 (14.73%)	81 (85.26%)			
Residence	**Urban area**	29 (14.95%)	165 (85.05%)	1.445	1	0.287^{ns}
	Rural area	2 (33.33%)	4 (66.67%)			
Who do you stay with?	**Parents**	16 (12.10%)	116 (87.90%)	15.002	3	**0.002** **
	Mother only	11 (23.90%)	35 (76.10%)			
	Father only	2 (100%)	0 (0.00%)			
	Guardian	2 (10.00%)	18 (90.00%)			
Family size	**2-3**	6 (18.80%)	26 (81.30%)	0.31	2	0.856^{ns}
	4-5	8 (15.10%)	45 (84.90%)			
	>5	17 (14.80%)	98 (85.20%)			
Parents age	**19-35**	19 (13.00%)	127 (87.00%)	3.57	2	0.168^{ns}
	36-52	11 (24.40%)	34 (75.60%)			
	>52	1 (11.10%)	8 (88.90%)			
Education	**Primary**	3 (21.40%)	11 (78.60%)	3.192	3	0.363^{ns}
	Secondary	11 (12.80%)	75 (87.20%)			
	Tertiary	13 (14.90%)	74 (85.10%)			
	I didn't go to school	4 (30.80%)	9 (69.20%)			

Age group in years	**0-4**	20 (14.50%)	118 (85.50%)	0.367	2	0.832 ns
	5-8	8 (18.20%)	36 81.80%			
	9-12	3 (16.70%)	15 (83.30%)			
Number of children	**One child**	13 (19.10%)	55 80.90%	1.704	4	0.79 ns
	Two children	14 (13.60%)	89 86.40%			
	Three children	4 (16.00%)	21 84.00%			
	Four children	0 (0.00%)	2 100.00%			
	Five children	0 (0.00%)	2 100.00%			

*** Significant at the 1% level of significance (α = 0.01).*

ns Not significant at the 5% level of significance (α = 0.05).

4.1.3 Prevalence of anemia according to the sociodermographic data

TABLE 4: Based on the results of the Chi-Square test of association between sociodemographic variables and the anaemia status of children aged 0-12years attending the Nkwen District Hospital Bamenda, all the sociodemographic parameters were not significantly (P-value > 0.05) associated with children's anaemia status at the 5% level of significance (α = 0.05) (Table 3).

Children aged 0-4years were more at risk 67(48.60%) of having anemia than the other age groups as well as childen who lived in rural areas 4(66.70%). children who lived with their fathers had more anemia 1(50.00%) as well as parent50.00%) as well as parents who had a secondary level of s who had a secondary level of education 42(48.80%).

Table 4: Chi square test of association between Sociodemographic variables and the anaemia statusof children aged 0-12years attending the Nkwen District Hospital Bamenda

Sociodemographic variables		Anaemia status		Chi square test summary		
		Yes	No	X^2	df	P-value
Gender	**Male**	49 (46.70%)	56 (53.30%)	0.638	1	0.424 ns
	Female	39 (41.10%)	56 (58.90%)			
Residence	**Urban area**	84 (43.30%)	110 (56.70%)	1.29	1	0.256 ns
	Rural area	4 (66.70%)	2 (33.30%)			
Family size	**2-3**	13 (40.60%)	19 (59.40%)			
	4-5	26 (49.10%)	27 (50.90%)	0.788	2	0.674 ns

	>5	49 (42.60%)	66 (57.40%)			
Age group in years	**0-4**	67 (48.60%)	71 (51.40%)	4.124	2	0.127 ns
	5-8	16 (36.40%)	28 (63.60%)			
	9-12	5 (27.80%)	13 (72.20%)			
Parents age	**19-35**	67 (46.66%)	79 (54.40%)	0.796	2	0.672 ns
	36-52	18 (40.00%)	27 (60.00%)			
	>52	3 (33.30%)	6 (66.60%)			
Number of children	**One child**	30 (44.10%)	38 (55.90%)	0.239	4	0.993 ns
	Two children	46 (44.70%)	57 (55.30%)			
	Three children	10 (40.00%)	15 (60.00%)			
	Four children	1 (50.00%)	1 (50.00%)			
	Five children	1 (50.00%)	1 (50.00%)			
Who do you stay with?	**Parents**	58 (43.90%)	74 (56.10%)	0.21	3	0.976 ns
	Mother only	21 (45.70%)	25 (54.30%)			
	Father only	1 (50.00%)	1 (50.00%)			
	Guardian	8 (40.00%)	12 (60.00%)			
Education	**Primary**	5 (35.70%)	9 (64.30%)	1.611	3	0.657 ns
	Secondary	42 (48.80%	44 (51.20%)			
	Tertiary	36 (41.40%)	51 (58.60%)			
	I didn't go to school	5 (38.50%)	8 (61.50%)			

ns Not significant at the 5% level of significance (α = 0.05).

4.1.4 Prevalence of malaria with Anemia according to Sociodermographic data

Children aged 0–12 who are attending the Nkwen District Hospital in Bamenda have a malaria-with-anemia status. The chi-square test of relationship between sociodemographic factors and this status is shown in Table 5. These findings showed that, at the 5% level of significance (α = 0.05), none of the sociodemographic factors were substantially (P-value > 0.05) linked to the children's malaria-with-anemia status.

In rural regions, malaria was more common in males with anemia (15, or 14.30%) and a marginally significant 1 (16.67%). The incidence was higher among those who lived with their father (50.00%) and among parents who did not attend school.

Table 5: Chi square test of association between Sociodemographic variables and the malaria-with-anaemia statusof children aged 0-12years attending the Nkwen District Hospital Bamenda

Sociodemographic variables		Malaria with anaemia		Chi square test summary		
		Yes	No	X^2	df	P-value
Sex	Male	15 (14.30%)	90 (85.70%)	1.685	1	0.194 ns
	Female	8 (8.40%)	87 (91.60%)			
Number of children	One child	9 (13.20%)	59 (86.80%)	1.543	4	0.819 ns
	Two children	10 (9.70%)	93 (90.30%)			
	Three children	4 (16.00%)	21 (84.00%)			
	Four children	0 (0.00%)	2 (100.00%)			
	Five children	0 (0.00%)	2 (100.00%)			
Residence	Urban area	22 (11.220%)	172 (88.76%)	0.233	1	0.37 ns
	Rural area	1 (16.67%)	5 (83.33%)			
Who do you stay with?	Parents	13 (9.80%)	119 (90.20%)	5.666	3	0.129 ns
	Mother only	8 (17.40%)	38 (82.60%)			
	Father only	1 (50.00%)	1 (50.00%)			
	Guardian	1 (5.00%)	19 (95.00%)			
Education	Primary	2 (14.30%)	12 (85.70%)	2.227	3	0.527 ns
	Secondary	8 (9.30%)	78 (90.70%)			
	Tertiary	10 (11.50%)	77 (88.50%)			

	I didn't go to school	3 (23.10%)	10 (76.90%)			
Family size	2-3	4 (12.50%)	28 (87.50%)	0.305	2	0.859 ns
	3-4	5 (9.40%)	48 (90.60%)			
	>5	14 (12.20%)	101 (87.80%)			
Age group in years	0-4	15 (10.90%)	123 (89.10%)	0.527	2	0.768 ns
	05-08	5 (11.40%)	39 (88.60%)			
	09-12	3 (16.70%)	15 (83.30%)			
Parents age	19-35	18 (12.3%)	128 (87.67%)	4.163	2	0.125 ns
	36-52	4 (8.89%)	41 (91.11%)			
	>52	1 (11.10%)	8 (88.90%)			

ns Not significant at the 5% level of significance (α = 0.05).

4.2 To assess the associated risk factors of malaria, anemia and malaria-with-anemia in children aged 0-12years

Table 6: Malaria, anemia, and malaria-with-anemia risk factors in children ages 0–12 who are treated at the Nkwen District Hospital in Bamenda

Based on the associated risk factors, majority of participant 198(99%) have heard of malaria also majority 156(78%) of the participants sleep under mosquito nets, with few of them 20(10%) living beside the bush. Majority of the participants 130(65%) lived in houses which were locked after 6pm while a smaller number of children 30(15%) used mosquito insecticides. Majority 163(81.5) of the parent\guardian had treated malaria in the past 6months and majority 63(31.5) treat malaria twice in a year. 35(17.5%) of the participants lived beside stagnant water. 49(24.5%) of them participants had been diagnosed of anemia with 24(12%) due to malaria.

Category	**Sub-category**	**Frequency**	**Percent (%)**
Have you ever heard of malaria?	Yes	198	99
	No	2	1
Sleep under nets	Yes	156	78
	No	44	22
Live beside the bush	Yes	20	10
	No	180	90
Outdoor sleeping	Yes	130	65
	No	70	35
use mosquito insecticides	Yes	30	15
	No	170	85
Stagnant water	Yes	35	17.5
	No	165	82.5

Diagnosed of malaria in the past 6months	Yes	163	81.5
	No	37	18.5
Malaria treatment in the household within a year	Once	43	21.5
	Twice	63	31.5
	Thrice	39	19.5
	More than three times	48	24
	Missing	7	3.5
Anyone being diagnosed anemia in the household	Yes	49	24.5
	No	151	75.5
Anemia due to malaria	Yes	24	12
	No	9	4.5
	Missing	167	83.5
Blood transfusion history	Yes	23	11.5
	No	177	88.5

4.2.1 Risk factors associated with malaria

The results of the Chi-Square test of association between the risk factors of malaria and malarial status in children aged 0-12 years attending the Nkwen District Hospital Bamenda are presented in Table 7. Out of all the risk factors considered in this study, four of them were significantly (P-value < 0.05) associated with malaria in children. Those who locked their doors after 6pm were more likely (19.20%) to have children who suffered from malaria compare to homes who lock their doors before 6pm (8.60%). Those who used mosquito insecticides were less likely (3.30%) to have children who suffered from malaria compared to those who did not use it (17.60%). Those who slept under mosquito nets were less likely to have malaria (6.4%) as compared to those who didn't (47.72%). Those who lived beside stagnant water were more (28.57%) at risk of having malaria. All the other malarial risk factors were not significantly (P-value > 0.05) associated with children's malarial status at the 5% level of significance (α = 0.05).

Table 7: Chi-square test of association between risk factors of malaria and malarial status in children aged 0-12 years attending the Nkwen District Hospital Bamenda

Risk factors of malaria	Response	Malaria		Chi square test summary		
		Yes	No	X^2	df	P-value
Sleep under nets	Yes	10 (6.4%)	146 (93.59%)	3.737	1	**0.391***
	No	21 (47.72%)	23 (52.27%)			
Live beside the bush	Yes	2 (10.00%)	18 (90.00%)	0.513	1	0.474 ns
	No	29 (16.10%)	151 (83.90%)			
Outdoor sleeping	Yes	25 (19.20%)	105 (80.80%)	3.947	1	**0.047***
	No	6 (8.60%)	64 (91.40%)			
Use mosquito insecticides	Yes	1 (3.30%)	29 (96.70%)	3.989	1	**0.046***
	No	30 (17.60%)	140 (82.40%)			
Stagnant water	Yes	10 (28.57%)	25 (71.42%)	3.899	1	**0.049***

	No	21 (12.73%)	144 (87.27%)			
Diagnosed of malaria in the past 6 months	Yes	23 (14.10%)	140 (85.90%)	1.299	1	0.254 ns
	No	8 (21.60%)	29 (78.40%)			
Malaria treatment in the household within a year	Once	7 (16.30%)	36 (83.70%)	0.141	3	0.987 ns
	Twice	9 (14.30%)	54 (85.70%)			
	Thrice	6 (15.40%)	33 (84.60%)			
	More than three times	8 (16.70%)	40 (83.30%)			

ns Not significant at the 5% level of significance (α = 0.05).

** Significant at the 5% level of significance (α = 0.05).*

4.2.2 Risk factors associated with anemia

Table 8: Based on Chi-square test of association between risk factors of malaria and anaemia status in children aged 0-12years attending the Nkwen District Hospital Bamenda (Figure 7), two of the risk factors (locking of doors after 6 pm and transfusion history) were significantly (P-value < 0.05) associated with anaemia in children. The respondents who locked their doors after 6pm were more likely (49.20%) to have children with anaemia compared to respondents who did not lock their doors after 6pm (34.30%). The transfusion history of the children was significantly (P-value < 0.05) associated with their anaemia status. Children who had been transfused before were more slidely (65.20%) to be anaemic compared to those who had not been transfused before (41.20%).

There was a slightly higher prevalence of anemia in areas where there was a bush had a higher prevalence 10(50%) than those who didn't have. There was no significant difference in houses that used mosquito insecticides and lived beside stagnant water and those that didn't. Those who had been diagnosed of anemia had a slightly higher prevalence 27(55.10%).

Table 8: Chi square test of association between risk factors of malaria in the anaemia status in children aged 0-12years attending the Nkwen District Hospital Bamenda

Risk factors of malaria	Response	Anaemia status		Chi square test summary		
		Yes	**No**	**X^2**	**Df**	**P-value**
Sleep under nets	Yes	69 (44.20%)	87 (55.80%)	0.015	1	0.901 ns
	No	19 (43.20%)	25 (56.80%)			
Live beside the bush	Yes	10 (50.00%)	10 (50.00%)	0.325	1	0.569 ns
	No	78 (43.30%)	102 (56.70%)			
Outdoor sleeping	Yes	64 (49.20%)	66 (50.80%)	4.124	1	**0.042***
	No	24 (34.30%)	46 (65.70%)			
use mosquito insecticides	Yes	13 (43.30%)	17 (56.70%)	0.006	1	0.936 ns

	No	75 (44.10%)	95 (55.90%)			
Stagnant water	Yes	17 (48.57%)	18 (51.42%)	2.527	1	0.115 ns
	No	71 (43.03%)	94 (56.97%)			
Anyone being diagnosed of anemia in the household	Yes	27 (55.10%)	22 (44.90%)	3.246	1	0.072 ns
	No	61 (40.40%)	90 (59.60%)			
Anemia due to malaria	Yes	14 (58.30%)	10 (41.70%)	0.509	1	0.475ns
	No	4 (44.40%)	5 (55.60%)			
Blood transfusion history	Yes	15 (65.20%)	8 (34.80%)	4.748	1	**0.029***
	No	73 (41.20%)	104 (58.80%)			

ns Not significant at the 5% level of significance (α = 0.05).

** Significant at the 5% level of significance (α = 0.05).*

4.2.3 Risk factors associated with malaria with anemia

The Chi-square test of the relationship between malaria risk variables and the malaria-with-anemia status in children ages 0–12 who are treated at the Nkwen District Hospital in Bamenda is displayed in Table 10. These findings showed that, at the 5% level of significance (α = 0.05), none of the malarial risk factors were substantially (P-value > 0.05) linked to the children's malaria-with-anemia status. At the 5% level of significance, we consequently draw the conclusion that there are no risk factors linked to the malaria-with-anemia status in children ages 0–12 who are treated at the Nkwen District Hospital in Bamenda.

Table 10: Chi square test of association between risk factors of malaria and malaria-with-anaemia status in children aged 0-12years attending the Nkwen District Hospital Bamenda

Those who didn't sleep under a mosquito net had a higher chance 16(36.3%) of having malaria with anemia and houses without a mosquito insecticides had more 22(12.90%). Stagnant water contributed 10(28.57%) to the prevalence of malaria with anemia. Those who locked their doors after 6pm had a slight increase 18(13.80%) in malaria with anemia than those who didn't.

Risk factors of malaria	Response	Malaria-with-anaemia		Chi square test summary		
		Yes	No	X^2	df	P-value
Sleep under nets	Yes	7 4.49%	149 95.5%	1.215	1	0.271ns
	No	16 36.30%	28 63.53%			
Live beside the bush	Yes	2 10.00%	18 90.00%	0.049	1	0.825 ns
	No	21 11.70%	159 88.30%			
Outdoor sleeping	Yes	18 13.80%	112 86.20%	2.009	1	0.156 ns
	No	5	65			

		7.10%	92.90%			
Use mosquito insecticides	Yes	1 3.30%	29 96.70%	2.313	1	0.128 ns
	No	22 12.90%	148 87.10%			
Stagnant water	Yes	10 (28.57%)	25 (71.43%)	1.523	1	0.571 ns
	No	13 (7.88%)	152 (92.12%)			
Number children diagnosed of malaria in the past 6months	Yes	18 11.00%	145 89.00%	0.181	1	0.671 ns
	No	5 13.50%	32 86.50%			
Malaria treatment in the household within a year	Once	4 9.30%	39 90.70%	1.078	3	0.783 ns
	Twice	6 9.50%	57 90.50%			
	Thrice	6 15.40%	33 84.60%			
	More than three times	6 12.50%	42 87.50%			
Anyone being diagnosed of anemia in the household	Yes	9 18.37%	40 81.63%	3.007	1	0.083 ns
	No	14 9.27%	137 90.73%			
Anemia due to malaria	Yes	5 20.80%	19 79.20%	0.416	1	0.519 ns
	No	1 11.10%	8 88.90%			

ns Not significant at the 5% level of significance (α = 0.05).

4.3 Anemia prevalence in children with malaria

In accordance with the findings, malaria was significantly (P-value < 0.001) associated with anaemia. The children with malaria were more likely to be anaemic compared to the children without malaria at a proportion of 26.10% to 7.10% respectively.

Table 11: Chi-square test of association between malaria status and anaemia status in children aged 0-12years attending the Nkwen District Hospital Bamenda

Malaria status*Anaemia status		**Anaemia**		**Chi square test summary**		
		Yes	**No**	**X^2**	**df**	**P-value**
	Yes	23 (26.10%)	65 (73.90%)			

	No	8 (7.10%)	104 (92.90%)	13.574		
Malaria					1	**< 0.001*** **

*** *Significant at the 0.1% level of significance (α = 0.001)*

5.0 Discussion

Anemia is still one of the leading causes of disability in the world, and Plasmodium is one of the most common human diseases. There is a complicated relationship between the two; while low iron levels may protect against malaria, anemia is also associated to malaria. This study looked at the risk of developing anemia and clinical malaria in kids who were treated at the Nkwen District Hospital in Bamenda.

Malaria is a public health concern in Bamenda and throughout Cameroon. We expected that 249 children would participate in this study, however we were only able to obtain informed consent from a sample of parents or guardians and children, respectively, giving us a participation rate of 200 (80.3%). In comparison to other studies, the prevalence of Plasmodium infection in 15.5% of children attending the Nkwen District Hospital was lower than that of a study conducted at Mount Cameroon, which found a prevalence of 27.7% [36], and higher than that of a study conducted in the Bui North West region of Cameroon, which found a prevalence of 12% [37].

The sole species of malaria parasite identified in this investigation was Plasmodium falciparum.

the connection between sociodemographic information and malaria. Of the study participants, 31 (15.5%) had a malaria diagnosis, while 169 (84.5%) did not. The majority of the infected children were male (17.20%) and the majority of the infected children were 8 (18.20%), aged 5-8. Overall, our study found no significant sex-based differences in malaria prevalence, with younger children experiencing lower rates of infection than older children. According to the findings, children who did not report sleeping beneath ITNs were 47.72% more likely to contract malaria than children who did. This outcome is in line with what previous research has found [38, 39, 40]. The greater usage of ITNs and other preventive measures may be the reason for the lower prevalence of malaria seen in our study.

The higher risk in older children found in this study, however, could be explained by two factors: younger children are more likely to sleep under ITNs and are therefore more protected, while older children are more likely to tolerate malaria parasites without getting feverish and thus have a higher prevalence of asymptomatic malaria parasitaemia. Furthermore, results from research conducted in the Mount Cameroon region have shown that, as a result of the improved preventative efforts in the ≤5 age group, the burden of malaria has transferred from this group to older age groups [41,42].

Anemia is a serious public health issue in the studied population, as seen by the 44% overall prevalence of anemia in children. This is less than the 60% national anemia prevalence [43] and Teh et al.'s findings [44]. Overall, 4.0% of children had hemoglobin levels below 7 g/dL.

As in previous investigations, the prevalence of anemia was somewhat higher in younger children than in older ones.[45, 46]. Anemia in children ages 0–4 was high in this research (48.6%). Iron shortage brought on by high iron requirements for quick growth, low iron intake from low iron content in breast milk and food items, and recurrent illnesses that interfere with feeding are all potential causes of anemia in younger children.[47, 48]

The age, education, and living arrangements of parents, as well as the size of the family, are sociodemographic characteristics that are inherently interconnected and strongly linked to childhood anemia. This indicates a connection between anemia and the demographic information. 84 (44%) of the study participants had anemia, with 49 (46.70%) of the anemic children being male and the majority (67, 48.60%) being children ages 0–4. Compared to the urban region, the rural area has a larger percentage of anemic children (66.7%). Anemia was more common in children who lived only with their father 1 (50%) and most anemic children 42 (40.8%) lived with a parent or guardian who completed secondary education. The plurality, 67 (46.66%), lived with parents or guardians who were between the ages of 19 and 35. According to earlier research, the majority of anemia was observed in children whose parents or guardians had four children or more (50%) [49,50]. Children of parents under 35 and those without a formal education were more likely to be anemic than children of other parents. Being under 25 may indicate that they are less equipped to meet the child's nutritional demands and adjust to motherhood as first-time parents. Lack of understanding about caregiving and anemia may also exacerbate this [51,52].

According to other investigations, anemia was statistically strongly linked to malaria parasite infection [44]. In this cohort, the total prevalence of malarial anemia was 11.5%.

This proportion is lower than the 27.7% previously observed in Cameroon[44]. Even though submicroscopic infection with Plasmodium falciparum infection has been associated with anaemia in other studies [53,54], the pathogenesis of malarial with anemia is said to be multifactorial but the exact mechanisms behind several haematology changes in the course of malaria is poorly understood [55]. The relationship between the sociodemographic data and malaria with anemia. The prevalence was higher in male 15(14.30) and also in the rural area 1(16.67%). The children with parents who didn't go to school 3(23.1%). Children whose parents were aged between 19-35 had a higher prevalence 18(12.3%)

The strong correlation between anemia and malarial age, parent age, and educational attainment is concerning. According to similar findings, individuals with male household heads had a higher prevalence of malaria and anemia 1 (50%) compared to those without male household heads. A study carried out in India found that homes with male heads are more likely to experience both malaria and anemia [56]. It is commonly known that in many African contexts, women typically take on the majority of caregiving responsibilities for other family members [57]. According to a study done in Nampula Province, Mozambique, [58], women are also more dedicated to encouraging disease prevention practices, like the use of LLINs, within their own families. The risk of infection was nearly four times higher for those with moderate-to-severe anemia.

Compared to earlier studies that have demonstrated that the use of mosquito control techniques, such as aerosol sprays and mosquito coils, is related with a lower risk of clinical malaria, children who did not use mosquito insecticides had greater rates of malaria and anemia [59,60].

In contrast to previous studies that have found a link between an increased risk of malaria and sleeping outside, children who lived in homes with doors locked before 6 p.m. had a lower incidence of both malaria and anemia [61,62].

Children who lived beside stagnant water had a higher risk of malaria and anemia than those who didn't as seen in studies carried out by kadobera D et al [63].

Malaria may contribute less significantly to anemia than other risk factors in study areas with lower parasitaemia carriage, particularly after the malaria burden has decreased [64]. This is evident in the risk factor based on transfusion history, where a higher percentage of children (65.2%) had anemia, which may be caused by genetic factors, malnutrition, or recurrent parasitic infections.

The prevalence of malaria and anemia was slightly higher in rural areas than in the urban setting as seen in several reports [65].

The prevalence of malaria and anemia was more prevalent in areas where there was no bush in contradiction to reports by other articles [66].

6.0 Conclusion

15.5%, 44%, and 11.5% of people have malaria, anemia, and malaria plus anemia, respectively. Given that the prevalence of anemia in children is still far higher than the 40% cut-off, more research is necessary to determine the underlying causes and create effective interventions. These may include iron supplementation, enhancing access to nutrient-dense foods, treating underlying infections and illnesses, and facilitating better access to healthcare services. Campaigns for education and awareness-raising can also aid in preventing childhood anemia and encouraging healthy habits.

The prevalence of malaria and anemia suggests that better malaria case management will probably lessen the burden of anemia, making it beneficial. Additionally, our study identifies some risk factors for malaria, anemia, and malaria with anemia that children aged 0–12 years encounter, including sex, parental age, child and parent age, single parent status, parental or guardian educational attainment, family size, environment, and some other intrinsic factors like the use of ITNs, sleeping outside, insecticide use, history of transfusions, and other infections. Therefore, strategies to reduce these risk factors are typically included in the planning of initiatives to address these public health issues.

6.1 Recommendations

To the Ministry of Public Health

- Educational campaigns on malaria and anemia in children should be made to educate both parents and children on malaria and anemia in an attempt to fight and reduce its morbidity and mortality rates.

To the Parents/Guardians

- Parents/guardians should ensure that their children sleep under long lasting insecticide treated mosquito nets and all measures to prevent malaria and anemia should be effectively implemented.
- Parents/guardians should ensure proper and healthy meals in order to prevent malnourishment which leads to anemia

Limitations

- To report anemia, we only used the hemoglobin level as determined by the Urit 12 strips and machine. The study did not look into the processes of anemia or prevalent causes of anemia in children, including schistosomiasis, HIV, parvovirus B19, malnutrition, and soil-transmitted helminths (STH). Thalassemia and sickle cell disease were not examined; instead, the main goal of the study was to.
- Self reported information provided by participants is a huge limitation because one can't solely rely on it.

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