SCHOOL OF PUBLIC HEALTH
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA, LEGON

FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN HIV-POSITIVE CHILDREN AT A HEALTH FACILITY IN ACCRA.

BY

ANITA MOMO TIBBOH

(10188701)

THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF PUBLIC HEALTH DEGREE

JULY, 2019

DECLARATION

I, ANITA MOMO TIBBOH, declare that this thesis is the outcome of my own original research undertaken under supervision, and it has never been presented for another degree in this university or elsewhere either in whole or in part. All contributing works have been duly acknowledged.

ANITA MOMO TIBBOH

Date 21/10/2019 Signature .....

MPH Student, School Of Public Health, College Of Health Sciences, University of Ghana.

Supervisor: DR. GLORIA FOLSON

Date 21/10/19 Signature .....

Department of Nutrition, Noguchi Memorial Institute of Medical Research, University of Ghana

DEDICATION

This thesis is dedicated to the Almighty God, and to my family.

ACKNOWLEDGEMENT

I am thankful to God for His divine provision throughout this programme.

I am grateful to my supervisor Dr. Gloria Folson for her supervision, and to the faculty and staff of the School of Public Health and the Department of Population Family and Reproductive Health for the knowledge I gained during this programme.

I appreciate the administration, staff and patients of the Princess Marie Louise Children's Hospital for granting me permission to use their facility for research. I am especially grateful to the patients of the special clinic for their participation in my research.

I am grateful to the WHO/TDR program for providing me with the opportunity and the sponsorship to do this program, and the staff of ORID for their support.

I also appreciate the staff of the Child Health Department – Korle-Bu Teaching Hospital for all their support during this programme.

Finally, I am eternally and deeply grateful to my family.

ABSTRACT

Background - Malaria and HIV are the two most common diseases of poverty among the leading causes of morbidity and mortality in sub-Saharan Africa. Their geographic distribution leads to high rates of coinfection where they overlap, and the synergistic interaction between the two diseases in cases of coinfection leads to invariably worse outcomes which is a major public health problem. Globally, both diseases contribute to over 4 million deaths yearly, and children are amongst the vulnerable populations affected. It is important therefore to know the burden of HIV–Malaria coinfection in children as well as its associated factors for implementation of necessary interventions, and scale up of the existing effective ones.

Objective - To explore the factors associated with HIV-Malaria coinfection in children.

Methods - The study is a facility-based cross-sectional study. The study population is HIV-positive children attending clinic at the Special Clinic of the Princess Marie Louis Children's Hospital.. Outcomes are HIV-malaria coinfection and anaemia, and independent variables are sociodemographic factors, health knowledge, health-seeking behaviour, nutritional status, malaria prevention practice, and HIV management. Bivariate analysis was done where applicable using Pearson Chi-square Test and Fischer's Exact Test and resulting significant variables were subjected to multivariate logistic regression to determine the predictors of the outcome.

Results - Prevalence of malaria was 13.89% (95%CI = 8.50-21.88), with 16.22% asymptomatic (95%CI = 8.23-23.66) and 8.82% symptomatic (95%CI = 2.75-13.64). Factors with an increased odds of HIV-malaria coinfection were a history of no breastfeeding (AOR=32.19, 95%CI = 2.99 – 345.89) and low socioeconomic status (AOR=6.52, 95%CI = 1.12 – 37.78). Factors with a reduced odds of HIV-malaria coinfection were medium dietary diversity (AOR=0.11, 95%CI = 0.02 – 0.63) and exposure to Septrin (AOR=7.12, 95%CI =

1.56-32.43). There were disparities between knowledge and practices on malaria prevention amongst caregivers. Prevalence of anaemia in the population was 10.19% (95%CI 5.69 – 17.56). There was no significant association between anaemia and dietary diversity, nutritional status and exposure to breastfeeding.

Conclusion - Prevalence of HIV-malaria coinfection was within the range provided in literature. Factors associated with HIV-malaria coinfection were poverty, the use of Septrin as prophylaxis, history of breastfeeding and a medium dietary diversity. The use of Septrin prophylaxis, history of breastfeeding and a medium total dietary diversity were protective against malaria. Nutritional status of HIV positive children was not associated with HIV-malaria coinfection. There are disparities between knowledge and practices on malaria prevention amongst caregivers due to low socioeconomic status.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACT	Artemisinin-based combination therapies
AFASS	acceptable, feasible, affordable, sustainable and safe
AIDS	Acquired Immunodeficiency Syndrome
ART	Antiretroviral therapy
BMI	Body Mass Index
EPI	Expanded Programme on Immunization
HIV	Human Immunodeficiency Virus
IPTp	Intermittent Preventive Treatment in Pregnancy
IRS	Indoor residual spraying
ITN	Insecticide-treated nets
LLIN	Long lasting insecticide treated nets
PML	Princess Marie Louis Children's Hospital
PMTCT	Prevention of mother-to-child transmission
RDT	Rapid Diagnostic Test
SMC	Seasonal malaria chemoprohylaxis
SSA	Sub Saharan Africa
TB	Tuberculosis
TMP-SMZ	Trimethoprim-sulfamethoxazole/Cotrimoxazole/ Septrin

UNAIDS	The Joint United Nations Programme on HIV/AIDS
UNICEF	United Nations Children's Fund
WHO	World Health Organisation

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Infectious diseases of poverty are diseases, which affect the poor and go on to worsen poverty in a vicious cycle of disease and poverty. This is because they may lead to prolonged illness, disability and stigmatization, which result in low productivity of adults, and also has adverse effects on child development and pregnancy outcome. They include the neglected tropical diseases, Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), malaria and tuberculosis (Bhutta, Sommerfeld, Lassi, Salam, & Das, 2014; Hotez & Kamath, 2009). Sub-Saharan Africa is estimated to bear greater than 90% of the impact of all these diseases combined with respect to death and disability, and has therefore been the recipient of various interventions targeted at these diseases (Bhutta et al., 2014).

Malaria and HIV are the commonest diseases of poverty in sub-Saharan Africa and other developing countries (Onankpa, Jiya, & Yusuf, 2017).

Malaria alone caused over a million deaths globally in 2012, with Africa suffering 81% of malaria cases and 91% of fatalities in 2010 (Bhutta et al., 2014). Malaria is caused by different sub species of the protozoan *Plasmodium sp*, with *Plasmodium falciparum* responsible for the majority and severest of diseases in sub-Saharan Africa. The parasite is carried by female *Anopheles* mosquitoes and transmitted via bites and blood meals. Sub-Saharan Africa is a malaria endemic region due to its geographical location. The infection results in a febrile illness with other non-specific symptoms (Cowman, Healer, Marapana, & Marsh, 2016) and often causes anaemia which has poor outcomes for child development and pregnancy.

Anaemia has far-reaching effects on health, social and economic development in low, middle and high income countries and is therefore considered a global public health problem (World Health Organization, 2015). In resource-poor areas like sub-Saharan Africa, there is a high prevalence of anaemia especially in women of childbearing age and in young children, who are also the most vulnerable (World Health Organization (WHO) & United Nations Children's Fund (UNICEF), 2004). Anaemia in these vulnerable groups is caused by infections and infestations, chronic diseases and hemoglobinopathies. Nutritional deficiencies of iron, folate, vitamins A and B12, also cause anaemia and are responsible for about 50% of the anaemia in resource-poor sub-Saharan Africa (Hotez & Molyneux, 2008; World Health Organization & United Nations Children's Fund, 2004). Anaemia is responsible for as much as 50% of malaria mortality in young children and has well-documented negative consequences on cognitive and physical development of children leading to poor school performance as well as reduced work productivity of adults (Hotez & Molyneux, 2008; World Health Organization, 2015; World Health Organization & United Nations Children's Fund, 2004)

HIV/AIDS is a viral disease transmitted through infected bodily fluids which ultimately results in severe immunosuppression thus the patient is at high risk of several opportunistic infections, one of which is malaria. Globally, over 65 million people have been infected with HIV, with 30 million deaths from AIDS- related causes since the disease emerged in 1981. About 1.5 million deaths were due to AIDS in 2010. Out of the 34million HIV cases worldwide as of 2011, 3.3million were children and 16.7million were women. Sub-Saharan Africa carries over two-thirds of the global burden of HIV (Bhutta et al., 2014).

Geographically, HIV and malaria have similar distribution worldwide, being found mainly in sub-Saharan Africa, India and Southeast Asia. Globally, the two diseases contribute to over

four million deaths yearly, and are leading causes of morbidity and mortality in sub-Saharan Africa (Naing, Sandhu, & Wai, 2016; Van Geertruyden, 2014)

Malaria is known to be a problem of vulnerable communities with exposure to environmental, socioeconomical and physical health risks, that often interact, resulting in more severe disease and worse outcomes (Van Eijk et al., 2007). Research has shown that the immunosuppression caused by HIV makes it a major risk factor for getting infected with malaria. HIV positive individuals get more severe malaria infections, and are more at risk of anaemia from the dual infection, malaria treatment failure and increased frequency of recurrent infection with malaria (Van Geertruyden, 2014) This is true for both adults and children, but children and pregnant women are the most severely infected (Cowman et al., 2016; Van Eijk et al., 2007).

There have also been studies showing that the malaria infection can induce some physiological changes that worsen the HIV infection leading to a faster progression to AIDS, and increases in viral load of the HIV-positive patient during febrile malarial episodes enhance susceptibility to recurrent malaria infection (Tay, Badu, Mensah, & Gbedema, 2015). Several interventions have been rolled out targeting HIV/AIDS and malaria globally. Strategies for HIV prevention include risk-reduction education, testing and counseling, condom use, male circumcision, preventive antiretroviral therapy (ART), and prevention of mother-to-child transmission (PMTCT). Subsidized antiretroviral drugs and chemoprophylaxis against opportunistic infections in the form of Trimethoprim-sulfamethoxazole (TMP-SMZ/ Cotrimoxazole/ Septrin) have been made available on a large scale to HIV-positive patients (Bhutta et al., 2014).

Interventions targeting malaria include preventive measures with insecticide-treated nets (ITNs); indoor residual spraying (IRS) with insecticide, chemoprophylaxis for pregnant

women and infants, and a vaccine (RTS,S/AS01 (RTS,S)) which is currently undergoing a pilot in sub-Saharan Africa, specifically Ghana, Kenya and Malawi, as well as prompt diagnosis and effective treatment with artemisinin-based combination medications (ACT); (Bhutta et al., 2014; World Health Organisation, 2018b). Among the HIV-positive population, studies have shown that together, the chemoprophylaxis (sulfadoxine-pyrimethamine) and ITNs (now known as long lasting insecticide treated nets – LLINs) already used in the general population have been effective in reducing malaria infection (Van Geertruyden, 2014). However, few of these studies have been done in children, who are one of the vulnerable populations, and there is limited literature about the burden of HIV –malaria coinfection amongst children in Ghana.

Given the huge population in sub Saharan Africa, it is postulated that even the smallest link between two diseases as widespread as HIV and malaria will be very significant in the region in terms of public health (Van Geertruyden, 2014). There is evidence that these two infections have a synergistic relationship with worse outcomes for the affected individuals, increased incidence of both, and more complicated treatments (Bhutta et al., 2014; Tay et al., 2015; Skinner-Adams, McCarthy, Gardiner, & Andrews, 2008). Available evidence shows that malarial parasitemia is commoner in HIV positive individuals, and low CD4+ counts result in higher rates of clinical malaria, with more severe disease, especially in children generally, but also pregnant women. This makes the HIV positive population critical in malaria prevention interventions since this population can form a parasite pool, raising the prevalence of malaria in the general population. Children under five are amongst the vulnerable groups targeted in malaria interventions because they are the most susceptible to infection, illness and death. They suffer over 70% of malaria deaths, and although mortality figures have declined with better interventions, a child dies from malaria every two minutes (World Health Organisation, 2018b). Several studies in Africa have found a higher

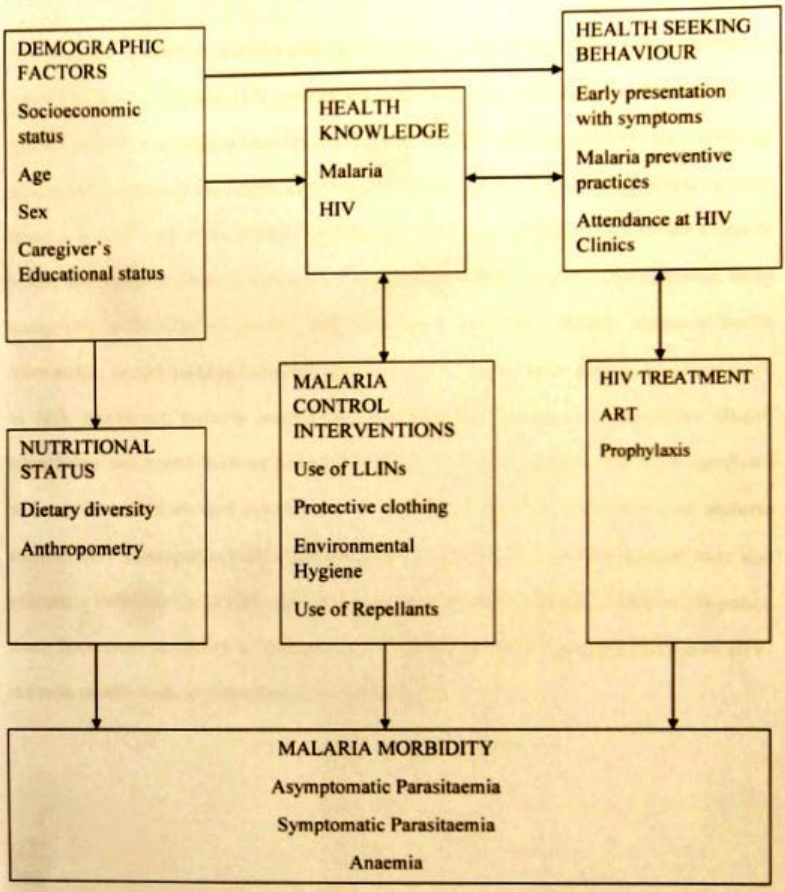
prevalence of malaria in HIV positive children than in children without HIV (Tay et al., 2015; Kwenti, 2018; Onankpa et al., 2017).

1.2 PROBLEM STATEMENT

The prevalence of HIV-malaria co-infection in Ghanaian children and its associated factors are not known, although malaria still accounts for more than 20% of child mortalities, and more than 45% of out-patient clinic attendance in Ghana (Tay et al., 2015b).

It is of importance to know the burden of malaria co-infection in HIV positive members of this age group as well as its associated factors to properly plan and allocate available resources to implement and possibly scale up the necessary existing interventions. HIV and malaria are noted to be significant causes of under-five mortality, and any data that contributes to the strategies to help alleviate their morbidity and therefore mortality should be welcome.

1.3 CONCEPTUAL FRAMEWORK



1.4 NARRATIVE SUMMARY (CONCEPTUAL FRAMEWORK)

The conceptual framework above seeks to show the relationships between various groups of factors related to malaria-HIV coinfection and their inter-relationships with each other. Malaria and HIV are said to be more prevalent in the poor, who may not have the knowledge or economic means to adequately protect their children from the devastating effects of either disease, or seek care when needed. Children are dependent on their caregivers for access to health and health-promoting activities. **Demographic** factors such as socioeconomic status comprising probability of poverty and educational level may directly influence **health knowledge, health seeking behavior** and utilization of health promoting interventions (such as **HIV treatment, malaria control and nutrition interventions**) of caregivers. **Health knowledge** and **health seeking behaviour** will in turn influence how and when caregivers will access healthcare, and whether or not they will adhere to interventions on **malaria control, HIV management** and **child nutrition**. Utilization of these interventions may also ultimately influence the **nutritional status** and **susceptibility to illness** of children. Together, these factors can be shown to influence the susceptibility of HIV-positive children to **HIV-malaria coinfection**, and **anaemia** as its complication.

1.5 RESEARCH QUESTION

What is the prevalence of malaria in HIV-positive children attending Special Clinic at the Princess Marie Louise Children's Hospital in Accra and which factors are associated with HIV-malaria coinfection?

1.6 STUDY OBJECTIVES

1.6.1 General objective:

To determine the prevalence and examine the factors associated with HIV-malaria coinfection in HIV-positive children aged 12 months to 12 years.

1.6.2 Specific objectives:

1. To determine the prevalence of malaria in HIV-positive children from 12 months to 12 years of age.
2. To examine the nutritional status of HIV-positive children from 12 months to 12 years of age.
3. To assess the health knowledge (HIV and malaria) and malaria prevention practices of caregivers of HIV-positive children 12 months to 12 years of age.
4. To determine the factors (anaemia, nutritional status and dietary diversity, Use of TMP-SMZ in HIV management, Use of LLINs) associated with malaria in HIV-positive children 12 months to 12 years of age

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 GLOBAL EPIDEMIOLOGY OF HIV AND MALARIA

Malaria and HIV are two of the deadliest diseases of our time. They are a major public health menace, affecting the poorest of a population, and can be said to be worsened and reinforced by poverty since they affect the workforce. Geographically, malaria and HIV are concentrated in the tropics and subtropical region which includes sub-Saharan Africa (SSA), thus the distribution of both diseases greatly overlaps in SSA, making coinfection common (Bhutta et al., 2014; Hotez & Kamath, 2009; Kwenti, 2018; Ouedraogo SM, Sangaré I, Sourabié Y, Zongo R, Zida A, Ouedraogo AS, Fofana S, 2015; Sangarei et al., 2015).

According to WHO, HIV is still a major public health issue worldwide with a head count of more than 35 million lives so far. Worldwide, in 2017 alone, there were 36.9 million people living with HIV, 1.8 million were new infections and 940 000 deaths resulted from HIV-related causes. The African Region is the most affected region, contributing to over 50% of new infections worldwide and about 70% of the 36.9 million people living with HIV globally in 2017 (World Health Organisation, 2018a)

Malaria is an infection caused by *Plasmodium* species which are protozoan parasites transmitted by *Anopheles* mosquitoes (Nkumama, O'Meara, & Osier, 2017). Majority of patients will have nonspecific symptoms with the infection such as fever and malaise, and will not require hospital admission. The infection may progress to severe malaria in a minority, presenting with fever, neurological manifestations such as impaired consciousness and seizures, severe anaemia and death, especially in children (Hotez & Kamath, 2009; Hotez & Molyneux, 2008; Nkumama et al., 2017).

Globally, malaria cases increased by 5 million cases in 2015 to an estimated 216 million in 2016, which is however an improvement compared to 237 million cases in 2010, with deaths from malaria remaining almost the same at 445 000 in 2016 (446 000 in 2015). Being a disease that is endemic to the tropics, the WHO African Region bore a high share of this burden with 90% of cases and 91% of deaths, followed by the WHO South-East Asia Region (7% of cases, 6% of deaths) and the WHO Eastern Mediterranean Region (2% of cases). Fifteen countries out of the 91 that contributed to these figures were from Sub-Saharan Africa, and they bore 80% of this burden. Similarly, these 15 countries accounted for 80% of the deaths. There was however a reduction in mortality across board compared with 2010, unfortunately the largest decline did not occur in the region that contributed the most – just about 37% in Africa (World Health Organisation, 2018; World Health Organization, 2017).

Children, especially those under five are especially susceptible to infection, illness and death in high transmission areas, suffering more than two thirds (70%) of all malaria deaths. There has been a decline in deaths in this age group from 440 000 in 2010 to 285 000 in 2016, however malaria is still a major killer of children under five years old (World Health Organisation, 2018).

2.2 EPIDEMIOLOGY OF HIV AND MALARIA IN GHANA

The year 1986 heralded the incidence of HIVAIDS in Ghana, recording the first 42 cases. As at the end of 2011 there were 225,478 persons living with HIV, with 65,087 on treatment, and 12,077 new infections including 1,707 in children (Ghana AIDS Commission, 2013) . By 2017, an estimated 313,000 people were living with HIV/AIDS comprising 284,860 adults (91%) and 28,203 children (9%). There were 19,101 new infections (82.1% adults, 17.9%

children) and 15,694 AIDS deaths. About 3,400 new child infections were estimated to have occurred among children 0-14 years, with 2,902 deaths for the year 2017. The number of AIDS orphans was approximately 186,000 (Ghana AIDS Commission, 2017).

In Ghana, HIV prevalence is estimated using sentinel surveillance of pregnant women attending antenatal clinics since 2003. The adult national HIV prevalence for 2017 is 1.67% (Ghana AIDS Commission, 2017) which is an improvement from a prevalence of 2.7% in 2005 (Ghana AIDS Commission, 2013).

HIV has negative impacts on every aspect of a country. It reduces life expectancy and productivity of the nation's workforce thereby negatively affecting the economy. It creates a massive burden for families by incapacitating breadwinners or creating orphans. Those living with the disease have to deal with social and psychological effects as a result of the stigmatization that it comes with. HIV/AIDS therefore contributes significantly to morbidity and mortality rates in Ghana(Ghana AIDS Commission, 2013)

Malaria is endemic to Ghana, which is a country that supports intense *P. falciparum* transmission, actually representing one of the most intense transmission countries in Africa (National Malaria Control Program, University of Health & Allied Sciences, AngloGold Ashanti Malaria Control Program, World Health Organization, & The INFORM Project, 2013). Malaria is one of the leading causes of morbidity and mortality in Ghana, said to be responsible for over 30% of all outpatient cases noted in health facilities across the country each year, 20% to 30% of deaths in children under five, and 11% of maternal deaths (President's Malaria Initiative, Ghana Health Service, United States Agency for International Development (USAID), & Centers for Disease Control and Prevention (CDC), 2013). *Plasmodium falciparum* which causes the most severe disease is the dominant *Plasmodia* species in the country. *Plasmodium vivax* has not yet been reported in Ghana, and *P.*

malariae and *P. ovale* are rare. The most prevalent areas are in the northern two-thirds of the country, where parasite rate in children can be as high as 50%. Ghana's current malaria status translates to a disease burden that is highest in children and also means that a majority of febrile illnesses that present to a health facility harbour the parasite even though that may not be the primary cause of the fever. This makes unique diagnosis difficult. (National Malaria Control Program et al., 2013; President's Malaria Initiative et al., 2013).

2.3 HIV – PATHOPHYSIOLOGY, MANIFESTATIONS, MANAGEMENT

HIV as a disease targets the immune system of an infected individual, which is the system that protects the body from infections and disease. The virus weakens the individual's defense, making such a person progressively immune-deficient resulting in increased susceptibility to all types of infectious and non-infectious disease that a healthy non-infected person would ordinarily fight and ward off (World Health Organisation, 2018a). An affected individual will initially not show signs and symptoms depending on the original state of his or her immune system, but within two to fifteen years, without intervention, the disease progresses to a state of complete immunodeficiency known as Acute Immune Deficiency Syndrome (AIDS) with the onset of opportunistic infections at which point it is quite obvious how ill the patient is, and it is these infections that eventually cause the death of the patient (World Health Organisation, 2018a). In the early stages, as immunodeficiency progresses, the individual becomes more and more susceptible to infections which may be more severe, fail to respond to usual treatments, or develop quicker and more severe complications (WHO, 2004; World Health Organisation, 2018).

HIV is transmitted via the exchange of bodily fluids between an infected and uninfected person. Such bodily fluids include blood, semen and vaginal secretions and breast milk.

Sexual intercourse is one of the main ways of transmission, and as such the idea that promiscuity spreads the disease has been the root of discrimination, with many people regarding infected persons as immoral, hence their condition. However, blood transfusions can transmit the disease even though the risk is lessened with the rigorous screening blood and blood products go through. Children can also contract the virus from their mothers in-utero, during delivery or through breast milk. Medical and cosmetic invasive procedures can also transmit the virus if instruments used are not sterilized or there was an accidental injury and therefore exposure to infected bodily fluids (World Health Organisation, 2018).

HIV is currently incurable and there are ongoing fervent efforts to find a cure. The role of intervention therefore is to prevent the infection in all populations especially in high-risk groups. In already infected people, intervention aims to suppress the virus using drugs such that it cannot attack the immune system, allowing the body to recuperate and regain its defense systems. In order to prevent the virus from getting resistant to any one drug, three drugs are used. This is known as combination chemotherapy. In addition to anti-viral chemotherapy, there is prophylaxis against opportunistic infections. These are infections that typically do not affect healthy individuals unless there is some immunodeficiency (World Health Organisation, 2018). Cotrimoxazole, also known as Sulphamethoxazole-Trimethroprim, as it contains those two antibiotics, or more commonly Septrin, is one of the common prophylactic agents used. It not only provides coverage for gram-positive bacteria like *Streptococcus pneumoniae*, gram-negative bacteria like *Escherichia coli* and non-typhoid *Salmonella*, but also parasites such as the protozoa *Toxoplasma gondii* and *Plasmodium falciparum*, and fungi like *Pneumocystis jirovecii* (Manyanga, Minzi, & Ngasala, 2014). These are the common pathogens that cause most opportunistic infections in HIV patients. Cotrimoxazole is usually started once the diagnosis is strongly suspected and confirmed. There is room for discontinuation once there is evidence that the body`s immunity is strong

enough to fight these opportunistic infections, however in resource poor countries where the risk of getting these infections is already high for the normal population, it is recommended that it is continued as it reduces morbidity irrespective of clinical disease stage or CD4 cell count (World Health Organisation, 2013). Randomized trials found that it improved survival while reducing the risk of opportunistic infections such as malaria. Other studies have found specifically that it has a prophylactic effect on malaria as well (Cheng et al., 2015; Manyanga et al., 2014; Slutsker & Marston, 2007; Suthar, Granich, Mermin, Annelies, & Rie, 2012). A study on pregnant women with HIV in Tanzania showed a reduction in prevalence of anemia and malaria with increasing adherence to cotrimoxazole (Manyanga et al., 2014).

Programs to prevent HIV infection include counseling to reduce risky behaviours, voluntary testing, and provision of post exposure prophylaxis. The WHO has put in place new recommendations to treat all people living with HIV and Ghana has agreed to do this (Ministry Of Health, 2016; World Health Organisation, 2018a). This has increased eligibility for ART from 28 million to all 36.9 million people living with HIV. From 2000 to 2017, there was a reduction of 36% in new infections and 38% in deaths attributable to a collaboration between civil society and Development Partners in national HIV programs worldwide. 11.4 million lives were saved due to ART in this period (World Health Organisation, 2018a). Globally, however the need exists for scaling up treatment in the vulnerable populations of children and adolescents. According to the World Health Organization (World Health Organisation, 2018a), in 2018, 54% of children living with HIV globally were on ART compared to 62% in adults.. WHO is therefore providing support in this regard, aiming at expanding access to treatment towards an ultimate goal of ending the AIDS epidemic by 2030 (World Health Organisation, 2018a).

2.4 MALARIA - PATHOPHYSIOLOGY, MANIFESTATIONS, COMPLICATIONS AND MANAGEMENT

Malaria is not a typical opportunistic infection, however it is endemic to several countries with a high HIV burden, and the geographical intersection of the two diseases means high risks of coinfection. HIV patients are already immune-compromised, and immunity is a factor in malaria transmission, thus it is an important consideration in managing HIV patients (Manyanga et al., 2014).

Malaria is a parasitic infestation caused by different species of the *Plasmodium* protozoa. *Plasmodium falciparum* is the most widespread species in Africa, causing the majority of disease and deaths globally, while *P. vivax*, *P. ovale*, and *P. malariae* infections are less common. *P. vivax* is dominant outside of sub-Saharan Africa. The vector that transmits the parasite is the *Anopheles* mosque with *An. gambiae sensu stricto*, *An. funestus*, *An. arabiensis*, being the most prevalent in Africa. Transmission is by the bite of the female anopheles mosquito – as the mosquito takes a blood meal, it injects parasite laden saliva into the bloodstream of its victim, beginning the infective process. Infection presents within ten to fifteen days in a normally healthy individual with the nonspecific symptoms of fever, rigors, anorexia, fatigue and general malaise, and chills (World Health Organisation, 2018b). These are usually quite mild and majority of patients will have simple or uncomplicated malaria which will not require hospital admission. The non-specificity of the symptoms also means the infection may be missed or misdiagnosed and therefore not treated. Severe malaria may then develop which will present with hyperpyrexia, anaemia requiring blood transfusions, seizures or coma and death (Tay et al., 2015; Cowman et al., 2016). This is especially seen in children who can develop long-term neurological sequelae. Uncomplicated malaria in children can also cause developmental and cognitive impairments. There may also be infection without symptoms, which is referred to as asymptomatic infection. This could occur

in people living in endemic regions where older people develop some immunity and as such do not show clinical disease while young children show severe clinical manifestations (Cowman et al., 2016; Frischknecht & Fackler, 2016). This does not however mean the disease is inert, as especially in pregnant women, this chronic or asymptomatic effect has dire consequences for both mother and baby, causing both neonatal and maternal anaemia and neonatal malaria. These can have far-reaching consequences for the fetus such as preterm delivery, low birth weight, intrauterine growth restriction and post-neonatal infant deaths (Van Eijk et al., 2007; Nkumama et al., 2017; Van Eijk et al., 2007b; World Health Organisation, 2018b).

Malaria transmission is dependent on the parasite, the vector, the human host, and the environment (World Health Organisation, 2018b).

Female *Anopheles* mosquitoes bite between dusk and dawn. Mosquitoes bite humans and animals in order to draw a blood meal to nurture their eggs. Preventing the bites of the mosquito is one way of breaking transmission (World Health Organisation, 2018b).

The *Anopheles* mosquitoes then lay their eggs in water, which hatch into larvae and then develop into adults. Aquatic habitats may be in the form of small puddles of fresh water such as those found during the rainy season, manmade water receptacles like car tyres, and swampy areas. Shortening the lifespan of larvae breaks transmission as the larvae are not able to develop into adults, and shortening the lifespan of adult mosquitoes will reduce the chance of ingested parasites developing and being transmitted. Human factors affecting transmission include immunity. Adults in high or moderate transmission zones often develop partial immunity with years of exposure, reducing the risk of severe disease, but children do not have this physiological ability. This means the highest burden of mortality and morbidity is in

young children. This explains why most malaria deaths in Africa occur in young children (Nkumama et al., 2017; World Health Organisation, 2018b).

Given the above factors of transmission, control programs and interventions are mainly targeted at vector control, which has provided much of the success in malaria control programs globally. Some vector control methods recommended by the WHO are the insecticide-treated nets (ITN) which prevent mosquitoes from biting and indoor residual spraying (IRS) which keeps mosquitoes from resting indoors and kills them when they do, thus cutting short their lifespan and preventing bites as well.

National malaria control programs across Africa have implemented interventions aimed at vector control using ITNs, IRS and killing off larval stages of vectors. As far back as 1993, there was a trial of ITNs in Navrongo in Upper East Region, which lasted till 1995, with retreatment of the nets biannually. Compliance was lower (50%) during the hot seasons compared to the rainy seasons (over 70%). There was a significant reduction of 17% in mortality in children between 1 month and 4 years (National Malaria Control Program et al., 2013). This is just one of several studies proving the effectiveness of ITNs (Eisele et al., 2012; Hotez & Kamath, 2009; Slutsker & Marston, 2007). Across sub-Saharan Africa, there has been an increase in household ownership of at least one ITN from 50% in 2010 to 80% in 2016, and between 2014 and 2016, 75% of ITNs were distributed through mass distribution campaigns either free of charge or heavily subsidized through door-door campaigns, antenatal clinics and child welfare clinics (World Health Organization, 2017).

Antimalarial medicines as preventive therapies or prophylaxis can also be used. WHO recommends "intermittent preventive treatment in pregnancy" (IPTp) using the antimalarial drug sulfadoxine-pyrimethamine for pregnant women, another high risk group. There is also

the seasonal malaria chemoprevention (SMC) program which uses the same drug plus amodaquine given every month to children aged 3-59 months, who live in high seasonal transmission regions in Sahel sub-region of Africa, recommended by WHO since 2012. This program has however been hindered by a lack of funding, and more than 10 million children who could have benefited, did not (World Health Organization, 2017).

Early diagnosis and treatment reduces disease, prevents deaths and contributes to a reduction in transmission. It is strongly recommended by WHO that only confirmed cases be treated, treatment without diagnosis is considered only when parasitological diagnosis is impossible. A confirmed test is parasite-based, either by microscopy or rapid diagnostic test. Test results do not take long and should be available in 30 minutes or less. Partnerships between health (through National Malaria Control Programs) and civil society (through manufacturers, non-governmental organizations) worldwide have ensured availability of rapid diagnostic testing kits. Of the 312 million kits delivered worldwide 269 million were to the WHO African Region in 2016 (World Health Organisation, 2018; World Health Organization, 2017).

Treatment of malaria is with Artemisinin-based combination therapy (ACT), which is currently the best available especially for *P. falciparum* malaria. Again, under the WHO and in partnership with pharmaceutical companies, ACTs have been heavily subsidized and provided either free or at low cost. Uptake of this intervention has been impressive, with an increase in the number of ACT treatments distributed by national malaria control programs worldwide from 192 million in 2013 to 198 million in 2016, with 99% being recorded in the WHO African Region in 2016 (Ngasala et al., 2011; World Health Organisation, 2018; World Health Organization, 2017).

Prompt treatment of cases effectively prevents the morbidity and mortality associated with malaria most especially in children. Not every fever is due to malaria, however seeking health care early leads to early diagnosis and treatment, preventing severe malaria. Eighteen national surveys across sub-Saharan Africa between 2014 and 2016 showed a median of 47% febrile children were taken to a trained medical provider for care, and 41% of febrile children aged under 5 years received an antimalarial drug. 70% of the general population who sought treatment for malaria in public facilities received ACTs, with children being more likely to be given ACTs (World Health Organization, 2017).

There is currently an ongoing pilot of a malaria vaccine known as RTS,S/AS01 (RTS,S), also known as Mosquirix which is an injectable vaccine providing partial protection against malaria in young children. The pilot began in 2018, and is in sub-Saharan Africa in Ghana, Kenya and Malawi, with the aim of using the vaccine as a complementary malaria control tool in addition to the core WHO-recommended preventive, diagnostic and treatment measures (World Health Organisation, 2018b). In Ghana, the vaccine is a part of the Expanded program on immunization (EPI), given at 6, 7, 9 and 24 months. The pilot is currently ongoing in selected districts in the Central, Oti, Bono, Ahafo and Volta regions (Sodjah & Bayali, 2019; WHO, 2017).

All National Malaria Control Programs are guided and supported by the WHO using the WHO Global Technical Strategy for Malaria 2016-2030 which was adopted by the World Health Assembly in May 2015 to provide a technical framework for all malaria-endemic countries towards malaria control and elimination (World Health Organisation, 2018b).

There is a concerted effort towards malaria control and elimination worldwide driven by international development partners working with the WHO especially in sub-Saharan Africa.

In 2016, these partners and the governments of malaria endemic countries together invested an estimated US$ 2.7 billion in malaria control and elimination efforts globally. The majority (74%) of these investments went towards control and elimination efforts in the WHO African Region. Governments of endemic countries contributed 31% of total funding (US$ 800 million) in 2016. The United States of America (USA), was the largest financer supporting with US$ 1 billion (38%) (World Health Organization, 2017).

2.5 HIV-MALARIA COINFECTION

Generally, there seems to have been an improvement in the uptake of interventions targeted at malaria control. However, there is a vulnerable population that seems to have been overlooked. Research has increasingly shown that there is an increased burden of malaria with increased rates of infection, complications and treatment failure where there is HIV-related immunosuppression (Van Eijk et al., 2007; Kuile, Parise, Verhoeff, & Udhayakumar, 2004; Omoti et al., 2013; Van Geertruyden, 2014)

Together, malaria and HIV account for over 2 million deaths globally every year. Both diseases have a high morbidity and mortality burden of these diseases, and have dire socioeconomic consequences at all levels from the individual to nationally. Interactions between the two diseases pose major public health problems and since they are diseases of poverty, they promote or ensure the progression of the vicious cycle of poverty, decreased productivity from prolonged illness and stigmatization, increased dependent populations and more poverty and disease. (Bhutta et al., 2014; Kwenti, 2018; Onankpa, Jiya, & Yusuf, 2017)

Recent studies showed a synergistic and bidirectional relationship between the two diseases which led to an increase in the adverse events caused by either infection. This effect is worse

in patients with advanced immunosuppression in AIDS (Kuile et al., 2004; Kwenti, 2018; Van Geertruyden, 2014).

The interaction between malaria and HIV is bidirectional. Malaria in HIV-infected patients causes increased viremia and reduced CD4+ T-cell count which worsens the clinical state of the patient and promotes HIV transmission, and the HIV patient is also more likely to have higher levels of parasitaemia (Ayisi et al., 2003; Kwenti, 2018; Omoti et al., 2013; Van Geertruyden, 2014). HIV also increases the frequency and severity of malarial infections, increasing the likelihood of complications such as anaemia, cerebral malaria and congenital malaria in neonates of HIV mothers and the likelihood of treatment failure (Kwenti, 2018; Omoti et al., 2013; WHO, 2004) and malaria increases disease progression from HIV to AIDS . Both diseases cause complex activation of immune cells, cytokines and antibodies, destroying the tightly regulated processes which lead to increased transmission of either disease. HIV can also reduce efficacy of antimalarial drugs and increase the likelihood of adverse events (Alemu, Shiferaw, Addis, Mathewos, & Birhan, 2013; Hochman & Kim, 2009; Manyanga et al., 2014; Suthar, Granich, Mermin, Annelies, Rie, et al., 2012).

Malaria and HIV each impacts the transmission of the other. Malaria increases transmission and prevalence of HIV by causing an increased viral load. It has been postulated that malaria amplifies the transmission of HIV (Alemu et al., 2013; Hochman & Kim, 2009; Kwenti, 2018; Njunda, Njumkeng, Nsagha, Assob, & Kwenti, 2016). HIV infection also increases parasitaemia and severe malaria through its immunosuppression. A study of 41 countries in sub-Saharan Africa theorized that HIV infection increased prevalence of malaria by 1.3% and malaria-related mortality by 4.9% (Kwenti, 2018; Longdoh Njunda et al., 2016; Omoti et al., 2013). Among Ugandan children living with HIV/AIDS, malaria was observed to cause a transient increase in viral load (Kwenti, 2018)

With the high double burden of both diseases, interaction between the two occurs frequently resulting in higher levels of viraemia in HIV patients and higher parasite loads (Holmes, Losina, Walensky, Yazdanpanah, & Freedberg, 2003; Omoti et al., 2013; Sanyaolu et al., 2013). This will result in a higher circulating biomass of both causative species, resulting in higher transmissions, higher potential for genetic interactions leading to mutation and higher biodiversity of both species (Birger et al., 2015; Cowman et al., 2016; Van Geertruyden, 2014). Children are already a vulnerable population to either diseases, and given their naturally lower levels of immunity than adults, they are at a much higher risk of co-infection, and need to be considered separately (Mbale et al., 2016; Onankpa et al., 2017; Sangarei et al., 2015).

A systematic review of HIV infection in Africa revealed malaria to be the third-highest cause of HIV-related morbidity. Prevalence of HIV-malaria coinfection was found to be 0.7%–47.5% in non pregnant adults, 1.2%–27.8% in children, and 0.94%–37% in pregnant women (Kwenti, 2018). Pooled prevalence of the coinfection through a meta-analysis performed in 2016 was found to be 26% in adults, 12% in pregnant women, and 9% in children (Naing et al., 2016).

There is evidence that patients accessing healthcare for HIV are actually protected from malaria through the wider use of insecticide-treated bed-nets, cotrimoxazole prophylaxis and antiretroviral therapy (Van Geertruyden, 2014). However that evidence is currently mainly in adults, not in children, who form a vulnerable population in malaria control. There is therefore the need to establish a knowledge base in children so as to identify the peculiar factors that affects HIV malaria coinfection in children.

The ART policy of Ghana (Ministry Of Health, 2016), has guidelines for coinfection with TB and hepatitis, however, there are none for coinfection with malaria. The burden of HIV-

malaria coinfection and its effects in both adult and pediatric populations have however been established to be quite significant (Tay et al., 2015; Kwenti, 2018; Manyanga et al., 2014; Naing et al., 2016). Quantifying the burden of HIV-malaria coinfection among the pediatric population has not been done in Ghana and this is needed to help establish the knowledge base necessary for the control programs to make meaningful additions to current interventions to help in control of both diseases especially in the pediatric population.

2.6 ANAEMIA

Anaemia is a common problem amongst children and pregnant women in SSA. The multiple causes of anaemia include HIV infection, malaria infection, malnutrition and worm infestations. The micronutrients iron, folate, vitamins A and B12 are involved in formation of haemoglobin and red blood cells and some immune components as such deficiencies of these cause anaemia and are actually responsible for about 50% of the anaemia in resource-poor sub-Saharan Africa, with iron deficiency being the most significant. A diet that is not diverse enough to include sources of these micronutrients may put the child at risk of anaemia and also a reduced immunity leading to increased infections and therefore more severe anaemia (Hotez & Molyneux, 2008; World Health Organization, 2015; World Health Organization & United Nations Children's Fund, 2004). Malaria alone causes anemia by hemolysis of the red blood cells and hypersplenism (exaggeration of the destructive function of the spleen) (Jegede et al., 2017; Manyanga et al., 2014). HIV patients have poor immunity against opportunistic infections (including malaria) and are therefore more vulnerable to becoming anaemic from those infections. The immune response and inflammation caused by the persistence of these infections results in an imbalance between erythrophagocytosis and erythropoiesis. This is more complicated in advanced stages where local lesions and opportunistic infections within the gastrointestinal tract leads to malabsorption leading to

nutrient deficiencies and impaired formation of haemoglobin (Heller & Shattuck, 1997; Jegede et al., 2017; Manyanga et al., 2014). Anorexia in both infections could also lead to poor dietary intake with malnutrition and anaemia as a consequence. Both infections are individually known causes of anaemia, and HIV immunosuppression contributes to more anemia through more severe malaria (Kwenti, 2018). Infants with the coinfection have an increased risk for severe anaemia given their peculiar nutrition requirements for optimum growth which is increased with any infection at all, and patients of all ages with Malaria-HIV coinfection have been found to be twice as likely to be anemic (Ewing et al., 2017; Kwenti, 2018; Kuile et al., 2004; Van Eijk et al., 2002; Van Geertruyden, 2014). They have also shown a steeper haemoglobin decline, and slower haematological recovery following successful malaria treatment which is attributed to impaired erythropoiesis and iron mobilization. There is evidence that anemia is the most common hematological abnormality in individuals with HIV and malaria co-infection (Ayisi et al., 2003; Jegede et al., 2017; Omoti et al., 2013).

2.7 CHILD CARE AND HEALTH

The health and care of children in general is peculiar in that they are highly dependent on others to care for them and provide good nutrition, a protective environment, access to healthcare when they need it, and adherence to medications, vaccinations and other health-promoting activities (Case & Paxson, 2002; Ofunne, 2014). The parent is therefore the gate keeper of their child's health. They make the decisions about the child's exposure to healthcare and the quality of healthcare received. They choose the food children eat, influence the physical activities the children partake in, are supposed to recognize any changes in the child's physical and mental health status, and are the primary influencer of a

child's living conditions. The choices they make are influenced in turn by their material resources and socioeconomic status, their knowledge of health practices, programs and favorable lifestyles as well as their practices towards their own health and health behavior (Case & Paxson, 2002; Yu, 2015)

2.7.1 Socioeconomic status, child care and child health.

It has been theorized that a child's social environment influences their health, and components of the social environment include parental (especially maternal) literacy, educational level, risk behaviour, preventive behaviour, use of medical services and social support. It is believed that a family's social position is closely related to the health risks that its small children are exposed to, influencing their health from the very beginning when the child is conceived through a mother's living conditions and general health during the pregnancy. For examples, parental smoking, short duration of breast feeding and low social support which are known to be associated with increased infant morbidity and mortality, have been found to be commoner in lower socioeconomic groups. There is therefore said to be an intergenerational transmission of socioeconomic status where parents with higher socioeconomic status have children who grow up to be of better health than children of parents with lower socioeconomic status, as a result of the antecedent set by their parents wealth on their health outcomes (Case, Lubotsky, & Paxson, 2002; Mangrio, Hansen, Lindström, Köhler, & Rosvall, 2011). Parents also make the decisions about the quantity and quality of healthcare that their children are exposed to (Case & Paxson, 2002) based on their ability to afford the care, and this is influenced by their socioeconomic status. Socioeconomic status has therefore been found to influence health seeking behaviour and utilization of health services of parents for their children in terms of economic access to different levels of healthcare.(Case et al., 2002; Case & Paxson, 2002; Yu, 2015).

2.7.2 Health knowledge, health seeking behaviour, child care and child health.

Studies in both developed and developing countries have found that parental educational status is closely related to child health risks and health outcomes. Low educational levels were associated with more health risks, worse social support, fewer health promoting factors and in general, negative health outcomes, and parental educational status has been found to improve the use of health care services, resulting in better knowledge and practices of child care , and therefore better health outcomes such as improved nutrition, higher immunization rates, and reduced child mortality especially in developing countries. Studies have shown for example that improving maternal education has been found to have extremely significant and positive effects on improving child health. (Bhakta & Ganesh-Kumar, 2014; Grosse & Auffrey, 1989; Mangrio et al., 2011; Sanders, Thompson, & Wilkinson, 2007; Yu, 2015) Parents decisions about the quantity and quality of healthcare that their children get is also influenced by their own knowledge and health practices in addition to socioeconomic status (Case et al., 2002; Case & Paxson, 2002; Yu, 2015). Their knowledge about health issues influences health seeking behaviour in terms of personal health promoting interventions and practices, the source of healthcare, the time within which care is sought, and also the danger signs that prompt a parent to seek care (Chuma, Gilson, & Molyneux, 2007; Wambui, Kimani, & Odhiambo, 2018). While utilization of healthcare services improves the healthcare of the child as far back as seeking antenatal care during pregnancy, the actual impact was found to be weakened by a lack of education of parents in a study in India – thus even when parents had ability to access care, the impact was reduced by their knowledge (Bhakta & Ganesh-Kumar, 2014).

2.7.3 Nutrition

A child's nutrition is influenced by the child care practices of the family, which is in turn influenced by family's socioeconomic status since the parents choose what the child eats

based on their knowledge about health, their income and their own health behaviours, and this is strongly influenced by the parent's educational status, especially the mother (Amugsi, Mittelmark, Lartey, Matanda, & Urke, 2014; Arya & Devi, 1991; Bhakta & Ganesh-Kumar, 2014; Case et al., 2002; Case & Paxson, 2002).

Childhood undernutrition encompasses both chronic and acute malnutrition, which coexist in much of the developing world. Acute malnutrition is usually associated with sudden and immediate crisis such as periodic food shortages whereas chronic malnutrition results from prolonged inadequacy of nutrition resulting from micronutrient deficiencies, poverty, chronic food insecurity, poor child care practices resulting in poor feeding and repeated episodes of ill-health such as such as infections, and poor access to healthcare and health promotion activities (Black et al., 2008; Glover-Amengor et al., 2016).

Nutritional status measured by the indices of height-for-age, weight-for height (BMI) and weight-for-age are indicators of chronic and acute malnutrition. Height-for-age is an indicator of stunting which describes linear growth retardation and cumulative growth deficit, and as such chronic malnutrition. Weight-for-height measures body mass in relation to body height or length, describes current nutritional status and is an indicator of acute malnutrition or wasting. Weight-for-age is a composite of height-for-age and weight-for-height, and takes into account both acute and chronic malnutrition (underweight) (Statistical Service Accra, 2015; World Health Organization, 2010).

It is estimated that 165 million of all children under five years worldwide are stunted and 52 million are wasted with Africa and Asia having the highest burden. According to the Ghana Demographic and Health Survey 2014 (Statistical Service Accra, 2015), 19% of Ghanaian children were stunted, 5% were wasted, and 11% were underweight. Micronutrient malnutrition is also highly prevalent - 66% of children under five years are anaemic, which

has effects on cognitive and physical development. Undernutrition is estimated to be responsible for 45% of all child deaths, making feeding key for child survival. Underweight, wasting and stunting respectively contribute to 19%, 14.6% and 14.5% of childhood mortality globally, vitamin A and zinc deficiencies contribute substantially to micronutrient deficiency related-deaths whilst iodine and iron deficiencies coupled with stunting alone, contribute to underperformance of children intellectually and their susceptibility to chronic illnesses and disability both in childhood and later in adulthood (Black et al., 2008, 2013; Glover-Amengor et al., 2016; World Health Organization, 2010). Malnutrition is a major problem globally, less than 25% of infants receive diets that meet criteria for dietary diversity and feeding frequency that are appropriate for age. Malnourished children are more likely to suffer and die from common childhood illness like diarrhoea, pneumonia, and malaria (World Health Organization, 2018a). Good nutrition promotes healthy growth and development, and when nutrition is optimal in the first two years of life, overall development and health is improved and the risk of chronic disease is also reduced (World Health Organization, 2018b).

Breastmilk continues to be an important source of energy and nutrients after six months, providing at least half and a third of the energy requirements between 6 to12 months, and 12 to 24 months. During illness, breastmilk especially reduces morbidity by providing energy and nutrients, and reduces mortality among children who are malnourished (World Health Organization, 2018b).

Generally, good nutrition in childhood starts with breastfeeding. WHO and UNICEF therefore recommend that children should be breastfed for up to two years or beyond if mother wishes, with early initiation of breastfeeding within an hour of birth followed by exclusive breastfeeding till six months, then complementary feeding with nutritionally-adequate and safe complementary (solid) foods at six months (World Health Organization,

2018b). The Ghana Health Service also agrees with these recommendations and advocates for exclusive breastfeeding for all infants (Ministry Of Health, 2007). Breastmilk is known to reduce childhood morbidity and mortality especially those from enteric infections and defective nutrition, as it provides the child with all the necessary nutrition and immunity from common infections (World Health Organization, 2018b). It is estimated that annually more than 800 000 lives of children under five years could be saved by optimal breastfeeding.

2.7.4 Care of the HIV positive child

The health of HIV infected children is especially delicate in terms of the fact that there exists a large percentage of HIV-positive children who have been orphaned by the disease and so their caregiver is not their parent. The caregivers may be a close or distant relation, a legal guardian or just a well-wisher. In some cases, the primary caregiver may entrust the child to a secondary caregiver who may not be an adult themselves. In South Africa for example HIV is referred to as the grandmother's disease because HIV orphans are usually cared for by their grandmothers (Ofunne, 2014). More than 60% of orphaned children in South Africa live in grandparent-headed households. The care of such children is therefore usually complicated and requires interactions between the healthcare provider, the caregiver and whichever social protection agent is applicable. Studies have shown that greater regimen knowledge among caregivers has been found to be a predictor of adherence to treatment, and lower health literacy has been found to be associated with poorer HIV/AIDS disease and treatment knowledge, and more negative perceptions about health. Knowledge, Attitudes and Practice (KAP) of caregivers who may or may not be HIV positive themselves is therefore an indicator of the care given to the children in their care. (Kalichman & Rompa, 2000; Martin et al., 2007; Ofunne, 2014).

Nutrition in HIV-positive children is particularly important because they need adequate nutrition first for normal growth and development, then for building up of their immune

systems which is affected the most by the HIV virus, and this effect is amplified by malnutrition (Heller & Shattuck, 1997). Like all children, breastfeeding imparts energy, nutrients and immune building components to the baby, reduce childhood morbidity and mortality especially those from enteric infections and defective nutrition in the HIV positive child just as in the general population (World Health Organization, 2018b).

Breastfeeding is however a problem for HIV positive new mothers due to the risk of transmitting HIV through breastmilk . As such there is a question about risks of transmission outweighing benefits of breastfeeding in the minds of most HIV positive mothers (Leshabari, Blystad, & Moland, 2012). To address these fears, there were guidelines for the introduction of replacement feeds exclusively once the feeds were "acceptable, feasible, affordable, sustainable and safe (AFASS), but if any of these conditions were absent, then exclusive breastfeeding was otherwise recommended, and this recommendation was accepted by Ghana (Ministry Of Health, 2007; WHO, 2002). There are therefore infants who are not breastfed because mothers could afford AFASS replacements feeds. These children will therefore not have the conferred immunity of breastmilk, and if they are found to be HIV positive, may be more at risk of infections and poor growth than breastfed HIV positive children (World Health Organization, 2018b). However, in most low-income countries, replacement feeds are not acceptable, feasible, affordable, sustainable or safe. Most African communities will not understand why a mother is not breastfeeding her baby, so even when mothers choose not to breastfeed, they bow to societal pressures that do not find breast milk substitutes acceptable, and end up practicing mixed feeding which increases the risks of transmitting the virus to the baby (Doherty, Chopra, Nkonki, Jackson, & Greiner, 2006; Leshabari et al., 2012; Thairu, Pelto, Rollins, Bland, & Ntshangase, 2005). These feeds are also quite expensive for most low income mothers as such either they cannot afford to even start, or they may start but cannot sustain it as the child grows and demands more and more food. In addition, preparing

breast milk substitutes is effort-intensive. The mother or caregiver must be able to read or understand the instructions that come with the milk, they must be able to grasp the whole concept of asepsis, disinfection, and proper storage of the milk. In most instances, these low-income mothers are of low educational status and cannot understand these processes, and often do not have access to potable water, electricity or some other sustainable fuel, to be able to adequately prepare feeds. As such, the use of breast milk substitutes in low-income settings have actually been found to rather be associated with increased morbidity and mortality (Suryavanshi et al., 2003b; World Health Organization & United Nations Children's Fund, 2016). Hence the evidence is towards supporting breastfeeding in all instances but especially in low-income settings. Currently, the WHO guidelines are that HIV-positive mothers (whether their infants are also infected, not infected or of unknown status) should practice exclusive breastfeeding for the first six months of life, introducing appropriate complementary foods thereafter and continue breastfeeding for at least 12 months. They may continue breastfeeding for up to 24 months or longer, just as is done in the general population, while being fully supported for ART adherence. They can stop breastfeeding once they can provide a diet that is nutritionally adequate and safe, without breast milk(World Health Organization & United Nations Children's Fund, 2016).

Weight loss and malnutrition have long been associated with HIV due in part to the physiological effects of the disease, but also to the fact that the disease is prevalent in low socio-economic classes, where poverty, poor feeding practices and poor sanitation all abound (Heller & Shattuck, 1997; Poda, Hsu, & Chao, 2017). The picture that was presented in the early campaigns for HIV programs was of an emaciated ill looking adult or child. Scientifically, the inflammatory response to the infection is thought to change nutrient metabolism leading to inadequate tissue deposition and therefore weight loss, and even micronutrient and macronutrient supplementation only resulted in modest benefits (PrayGod,

Friis, & Filteau, 2018) Currently, nutritional support combined with the emerging drug therapies is considered critical for survival, and for a better quality of life. Good nutrition for children in particular provides them with the opportunity for normal growth and development as well as optimum immune functioning (Heller & Shattuck, 1997).

The HIV-positive child needs a positive social environment with caregivers who are knowledgable and have the capability for effective child care, good social support, effective antiretroviral therapy, and optimum nutrition to be able to grow and thrive in spite of all the challenges childhood and HIV presents. As at the end of 2016, there were 160,000 new infections and 120,000 AIDS-related deaths among children. There are gaps in evidence with respect to best practice in diagnosis, management and service delivery to children living with HIV. These gaps show the need for research to introduce and speed up interventions as well as overcome any obstacles to implementing existing interventions (Heller & Shattuck, 1997; Penazzato et al., 2018)

CHAPTER THREE

3.0 METHODS

3.1 STUDY DESIGN

The study was a facility-based cross-sectional study conducted at the Princess Marie Louise Children's Hospital (PML) in the Ashiedu-Keteke district of the Accra Metropolitan Assembly

3.2 STUDY SITE

The Princess Marie Louise Children's Hospital (PML) was the facility chosen for the study due to the fact that the population of interest was readily available with all the possible variables being present.

It is a district hospital by designation, however by virtue of it being solely for children, it is also a referral centre from other facilities across the country. It has a daily child welfare clinic for routine immunizations and follow-up of well children, a community rehabilitation centre for malnourished children, out-patient, in-patient and emergency services and it is also an ART centre for HIV-positive children and adults. It is a National Health Insurance accredited facility.

Princess Marie Louis Children's Hospital is in the centre of Accra, located within the major business district of the capital city, and serves the children of traders, business people and many others cutting across all socio-economic strata.

It has specialist clinics run by both resident and visiting pediatric specialists, a dental clinic and pharmacy and is also a centre for training residents in paediatrics, family medicine, paediatric surgery as well as other health professionals.

The special clinic run at PML serves HIV positive children, and retro-exposed children from across the country. It provides general care, counseling services, nutritional rehabilitation and anti-retroviral therapy. Retro-exposed children are those born to mothers who are HIV positive and have therefore been exposed to the virus either in-utero, during delivery or through breast-feeding but have not been confirmed to be HIV-positive. The clinic is also family-oriented and provides services to adult family members of its clients.

Table 1. Study variables

VARIABLE	OPERATIONAL DEFINITION	SCALE OF MEASUREMENT	TYPE
DEPENDENT VARIABLES			
Cases (HIV-Malaria coinfection and anaemia)	Any child who meets the inclusion criteria, tests positive for malaria with or without anaemia (Hb less than 8g/dL)	Categorical	Nominal
INDEPENDENT VARIABLES:			
Socio- demographical factors			
Age of child	Age at last birthday	Continuous	Ratio
Sex of child	Sex of child	Categorical	Nominal
Relationship between child and caregiver	Biological relationship or otherwise between child and caregiver	Categorical	Nominal
Caregiver's educational status	Highest level (complete/incomplete) of caregiver	Categorical	Nominal
Poverty probability index	Likelihood of child's household to be living below the national poverty line using a Poverty Probability Index	Categorical	Ratio
Behavioral factors			
Caregiver's knowledge of Malaria	Adequacy or otherwise of caregiver's knowledge of malaria vector, transmission, fatality and prevention methods	Categorical	Nominal
Caregiver's practice of malaria prevention methods	Adequacy or otherwise of caregiver's practice of malaria prevention methods	Categorical	Nominal
Caregiver's knowledge of HIV	Adequacy or otherwise of caregiver's knowledge of HIV transmission	Categorical	Nominal
Health seeking behavior	Whether caregivers will present early at health facilities, and the most likely source of healthcare they would access	Categorical	Nominal
Nutritional status:			
Anthropometry	Height and weights of children used to compute anthropometric indices	Categorical	Nominal
Dietary diversity	Dietary diversity scores based on 24-hour dietary recall	Continuous	Ratio
Breastfeeding practice	Whether or not child was breastfed, and duration of exclusive breastfeeding.	Categorical	Nominal
HIV management			
Prophylaxis	Use of Co-trimoxazole for opportunistic infection prophylaxis	Categorical	Nominal
Anti-retroviral therapy	Whether or not the child is on HIV treatment	Categorical	Nominal
HIV staging	Clinical stage of HIV as at time of interview	Continuous	Ratio

3.3 SAMPLING

3.3.1 Study population

Children who have been confirmed to be HIV-positive and were attendants at the Special Clinic at Princess Marie Louise Children's Hospital during the time of the study.

It is said that death of children under one-year of life contributes to 75% of all under-5 mortality, and this could be due to several factors including congenital diseases, infections and malnutrition. This study tried to remove these confounders by limiting the minimum age of participants to 12 months. The study also sought to look at dietary diversity which is advocated for from 6months such that by 1 year there should be an appreciable dietary diversity for children's diets. Secondly, at the time of the study, children above 12 years could not access National Health Insurance Scheme (NHIS) in pediatric departments in some hospitals unless they used adult facilities. For this reason the upper limit for children to be included across board for all the hospitals to be included was 12 years.

Inclusion Criteria:

- Children aged between 12months to 12years.
- Confirmed HIV positive
- Attendant at the Special Clinic
- Consent given

Exclusion Criteria:

- Caregivers who refuse consent
- Children below 12 months and above 12 years

3.3.2 Sampling approach

Consecutive sampling was done of all clinic attendants who met the inclusion criteria till the sample size was reached. This was done because the special clinic is made up of both children who are HIV-positive and those that are retro-exposed. Retro exposed children are

those born to HIV-Positive mothers, but whose HIV-status is yet to be determined. They are therefore managed and monitored in the clinic till their status is certified.

3.3.3 Sample size

Prevalence of HIV-malaria co-infection (27.8%) used in sample size collection was from a meta-analysis conducted by Kwenti (2018), where prevalence in Nigerian children under 18 years was 27.8%, which fell within the range of 1.2 to 31% found by the meta-analysis.

Using this prevalence, sample size of 308 was calculated. Accounting for 10% non-response rate brought the sample size to 338. The formula below was used in the calculation.

$n = (z^2pq)/d^2$

n = sample size for HIV-positive children under 5

z = $_z$ value for a two-sided test corresponding to the chosen α

p = estimated prevalence of children with HIV = 27.8% (Kwenti, 2018)

d = margin of error on p (set at 5%)

q: 1-p

The PML Special clinic had an average weekly attendance of 15 during the study. Considering the estimated clinic attendance, and the clinic population, a finite population correction formula was used in consultation with a biostatistician and sample size of 70 was obtained. This was adjusted by 10% non-response rate to 77.

The finite population correction factor formula is as follows:

$n = n_0 N / n_0 + (N-1)$, where

n = corrected sample for a finite population

N = the finite population (average attendance over six weeks - 90)

n_0 = the sample size using the prevalence of 27.8% - 308

Sample size of 70 was obtained. This was adjusted by 10% non-response rate to 77.

3.4 STUDY VARIABLES

Dependent variables: Cases of HIV-malaria coinfection measured by – symptomatic and asymptomatic parasitaemia, and anaemia.

Independent variables:

- Socio- demographical factors: Poverty likelihood, caregiver's level of education, age, sex
- Behavioral factors: Caregiver's knowledge of malaria and practices of malaria prevention, HIV knowledge, Health seeking behaviour
- Nutritional status: anthropometry, dietary diversity, breastfeeding practice
- HIV management: Use of Co-trimoxazole, Anti-retroviral therapy, HIV Staging

3.4.1 Data collection procedures and tools

Malaria was tested using the Malaria *Plasmodium falciparum* (P.f.) Rapid Test Device, an instant malaria rapid diagnostic test kit (RDT) as well as microscopic diagnosis for each sample of capillary blood. Haemoglobin levels were tested using a Hemocue® Hb 201+ device. Measurements of weight and height were taken for all study participants in duplicate and mean values of the measurements computed and used in analysis. An interview using a structured questionnaire was performed to determine knowledge of malaria (transmission,

symptomatology and prevention) health seeking behaviour and prevention practice, and HIV knowledge. The interview also included a 24-hour dietary recall to assess dietary diversity.

3.4.1.1 Malaria testing procedure

This was done using the Malaria *Plasmodium falciparum* (P.f.) Rapid Test Device, an instant malaria rapid diagnostic test kit (RDT) as well as microscopic diagnosis for each sample. The RDT is a parasite specific test that detects the presence of *P. falciparum* antibodies in the blood, with a sensitivity >99% and a specificity of 99.7%. The pad of the middle finger was cleaned with an alcohol swab; and capillary blood obtained by pricking the cleaned site with a sterile lancet. The blood sample was applied to the well of the rapid diagnostic test kit cassette, and two drops of the provided assay diluent was added to the blood sample in the well. Test results were read after ten minutes but not beyond twenty minutes. Appearance of both test and control lines in the reading window was a positive result, presence of the control line alone was negative, and absence of the control line was an invalid result.

For microscopic diagnosis which is the gold standard, thick and thin blood films were prepared using a drop of capillary blood after following the finger prick procedure above, and the films fixed and stained with Giemsa stain. The blood films were read by a qualified biomedical scientist for the presence of malaria parasites.

3.4.1.2 Haemoglobin test

Haemoglobin levels were tested using a Hemocue® Hb 201+ device. After the aseptic finger prick procedure described for the malaria testing, the microcuvette of the Hemocue® were filled with blood and placed in the device. The results displayed on the digital display were recorded. Anaemia was classified as Haemoglobin less than 8grams per deciliter, which is the cut off for malaria-related anaemia (Ghana Statistical Service (GSS), 2017).

3.4.1.3 Anthropometry

Measurements of weight and height were taken for all study participants. All measurements were taken twice, and mean values of the measurements computed and used in analysis.

1. Length - Recumbent length was taken of children too young or unable to stand. This was done by laying the child on their back along the length of the measuring board, with their head against the fixed head board, compressing the hair. The head was positioned so that an imaginary vertical line from the ear canal to the lower border of the eye socket was perpendicular to the board, with the child's eyes looking straight up. Care was taken to ensure that the child's shoulders were touching the board, and the spine was straight and not arched. The child's legs were held down, with gentle pressure applied to the knees in order to straighten the legs as much as possible without causing pain or injury. In this position, the footboard was pulled against the child's feet ensuring that the soles were flat against the footboard, with the toes pointing upwards. At this point the measurement of the child's length was taken and recorded in centimetres to the last completed 0.1 cm.

2. Height – Height was measured standing upright for children able to stand. Measurements were taken with Leicester Height Measures to the nearest 1cm. The height measures were placed on a level surface. The subject was asked to stand on the 'footprints' of the height meter barefoot with heels together and touching the backstop. Care was taken to ensure that the legs were straight and the buttocks and shoulder blades were touching the height meter. The head was placed in the Frankfurt Plane and the measuring arm lowered firmly onto the head. The height was read to the last completed millimeter at the red arrow pointing to the metric scale.

3. Weight –Weight was measured using the Tanita Electronic Scale WB-100A/WB-110A Remote Display Version scale. In order to take accurate measurements, the scales were

placed on level ground, with the four adjustable feet, ensuring that the bubble in the level gauge fell in the middle of the frame. The scale was then switched on, and when the reading was 0.0kg, the child was asked to mount the scale barefoot and wearing only light clothing. They were asked to stand still on the middle of the scale until the weight was displayed and recorded. Tared weighing was done for children less than 2 years and those unable to stand on their own. The caregiver or mother was weighed alone as described above. After the weight appeared on the display, he or she remained standing on the scale while it was re-set to zero. The child was then given to him or her and the child's weight was then recorded.

The indices of weight-for-age, weight-for-height and height-for-age were determined using the WHO AnthroPlus software (World Health Organization, 2018c)

3.4.1.4 Nutritional Assessment

Dietary diversity was measured using the dietary diversity questionnaire and score. Participants provided a 24-hour dietary recall which was used to indicate the presence and absence of food groups of interest in the diet. A score was computed based on the food groups that were present, and this score served as a qualitative measure of the child's access to, and consumption of a wide variety of foods, and also used as a proxy for nutritional adequacy for the micronutrients of interest - Iron, Vitamin B12, Folate and Vitamin A which are known causes of anaemia.

3.4.1.5 Interview

Caregivers were interviewed with a structured interviewer-administered questionnaire to determine knowledge of malaria (transmission, symptomatology and prevention) health seeking behaviour and prevention practice, and HIV knowledge. The questionnaire was

administered electronically using Tecno tablets with ODK Collect open source software installed on it.

Socioeconomic status was assessed using the Poverty Probability Index, which is a statistically rigorous, cheap and easy to use way to measure poverty. It is a tool to measure the poverty level of the household by estimating the likelihood that a household has income below a national or international poverty line using a specific set of questions with a specific scoring system. It is country specific and is modified using national surveys as and when they are updated. The Ghana PPI 2012 used in this study was created in March 2015 using Ghana's 2012/13 Living Standards Survey to measure the likelihood that the respondent's household was living below the national poverty line. Respondents were grouped into two categories – non-poor for those with 0% likelihood for living below Ghana's poverty line, and poor for those with a greater than 0% likelihood for living below Ghana's poverty line, as proxies for good socioeconomic status and poor socioeconomic status respectively.

3.4.1.6 Medical Records

Information on HIV staging, chemotherapy with Anti-retroviral agents, prophylaxis with Co-trimoxazole was obtained from the medical records of study participants.

3.4.2 Management of patients

Participants who tested positive for malaria were referred to their clinician for further management. Oral ACTs were provided to the facility for dispensing to participants of the study. Participants with severe anaemia were also referred to their primary caregiver for appropriate care – they were however known to the clinician and were being managed as at the time of the study.

3.5 DATA PROCESSING AND ANALYSIS

Data captured on the field was extracted to a central database using ODK Collect, and then to Microsoft Excel 2016, which was then made available to the PI. The use of electronic data collection eliminated the time and effort associated with data entry. Data was cleaned before being analysed with Stata Statistical Software 15 (StataCorp, 2017).

Pearson Chi-square Test, Fischer's Exact Test and logistic regression was used in the bivariate analysis between the dependent and independent variables where applicable. Independent variables which showed a statistically significant associations with the outcome variable by the univariate analysis were then subjected to multivariate logistic regression to determine the predictors of the outcome. Significance of the difference or association was pegged at a P-value of < 0.05.

3.6 QUALITY CONTROL

Research assistants were trained in using the ODK Collect questionnaires on the tablets. It is a software that is well validated for safety, accuracy, confidentiality, ease of use and completeness of data collected from the field. The software could be used offline and as such did not need internet connectivity to be operated. Internet was only needed to upload finished questionnaires at the end of data collection daily. Data was available to the principal investigator in real time.

A general nurse was also recruited as a research assistant specifically to take blood samples, prepare blood films and take anthropometric measurements. She was trained by a qualified biomedical scientist to take the samples and prepare blood films. The biomedical scientist was also available to the research team throughout the study period for supervision.

A qualified biomedical scientist was recruited to stain and read blood films at the end of data collection sessions.

3.7 ETHICAL CONSIDERATION

Ethical approval was obtained from the Ghana Health Service Ethics Review Committee (**GHS-ERC047/02/19**). Permission was sought from and granted by the management of PML Hospital.

The study and its blood sampling procedures were explained to participants and caregivers in clear and simple terms in their preferred language with the help of an interpreter where necessary. Written and signed informed consent was sought and obtained from all parents and caregivers, and assent was sought from children older than seven years, for inclusion into the study. It is a well known-fact that in Ghana, most caregivers do not disclose the HIV-status to their wards/children (Kallem, Renner, Ghebremichael, & Paintsil, 2011). To avoid pre-empting disclosure, the title of the study on the information sheets, consent and assent forms was amended to remove the words HIV-Positive, since some of the children had some level of understanding and curiosity.

Inclusion was strictly voluntary; clinic attendants who refused consent were not penalized in any form. All attendants had their routine clinic care with no interference from the study.

Data was kept confidential by coding all entries so personal data was untraceable. The final database was password-restricted and accessible only by the PI.

All participants were provided with compensatory packages consisting of snack packs of Kalyppo fruit drink, Nestle® Milo chocolate energy drink and Nido® powdered milk.

There is no conflict of interest to declare.

The study was funded by the World Health Organization through the WHO/TDR program at the University of Ghana School of Public Health.

CHAPTER FOUR

4.0 RESULTS

The research is a facility based cross-sectional observational study conducted at the Princess Marie Louise Children's Hospital (PML) in the Ashiedu-Keteke district of the Accra Metropolitan Assembly, between 21st May to 18th July 2019.

Socio demographic characteristics of the study population are described, followed by presentation of the prevalences of anaemia and malaria in the population, a descriptive analysis of the nutritional status of the study population, knowledge and practices of malaria, malaria control and HIV of the caregivers and then a presentation of the factors associated with malaria in the children who were found to have the co-infection.

A total of 108 children were recruited into the study. Mean age of the study participants was 55.31months (95%CI 48.65- 61.98). There were 64 (59.3%) males and 44 (40.7%) females. 76 (70.4%) of the children were under five years of age, and 10% were over 10 years.

A vast majority (92.6%) of the caregivers accompanying the children to clinic was female, and they were spread out almost equally across all age groups. Just one caregiver (0.9%) was elderly. Majority of caregivers (94%) had some level of formal education, most had primary or secondary education and 7.4% had tertiary education.

In terms of socioeconomic status, the households the children were coming from were almost equally distributed across the national poverty line. About 51% were coming from households that were likely to be living below the national poverty line, and 49% were likely to be living above the national poverty line. Poverty probability, as a proxy for socioeconomic status, was computed using the Poverty Probability Index specific to Ghana. This was done using a set of questions about the household size, building materials of the home, access to a toilet, and household assets such as mobile phones, televisions, and

vehicles. Each answer had a specific score, and the total score was read on a Poverty Likelihood table to give a percentage likelihood of living below the national poverty line. Scores of 65 and above had a 0% likelihood of living below the national poverty line and were classified as non-poor, and scores below 65 had more than a 0% likelihood of living below the national poverty line, with the likelihood increasing as the score reduces. For this research all households with more than a 0% likelihood of living below the poverty line were classified as poor.

4.1 SOCIODEMOGRAPHIC CHARACTERISTICS OF STUDY PARTICIPANTS

Table 2. Socio-demographic characteristics of the study population

Characteristics	HIV-Malaria Coinfection N (%)	No HIV-Malaria Coinfection N (%)
Sex of child		
Male(ref)	11(17.19)	53 (82.81)
Female	4 (9.09)	40 (90.9)
Age of child		
< 5(ref)	16(21.05)	60(78.95)
5 to 10	4(18.18)	18(81.82)
> 10	0	10(100)
Sex of caregiver		
Male(ref)	3(37.50)	5(62.50)
Female	17(17)	83(83)
Age of caregiver		
15 – 30 (ref)	8(22.22)	28(77.78)
31 - 40	8(21.05)	30(78.95)
41 - 60	4(12.12)	29(87.88)
Above 60	0	1(100)
Educational level of caregiver		
None(ref)	1(7.14)	13(92.86)
Primary	7(17.50)	33(82.50)
Secondary	10(25.64)	29(74.36)
Post Secondary/ vocational	2(28.57)	5(71.43)
Tertiary	0	8(100)
Socioeconomic status		
Poor	12(21.82)	43(78.18)
Non-poor	8(15.09)	45(84.91)

In 78% cases recruited, the relationship between the caregiver and the child was a parent-child one. Grandparents were caregivers in 11% of cases, siblings and other relatives were caregivers in about 10% of the cases, and the children were not biologically related to their caregivers in about 2% of cases (Fig. 1).

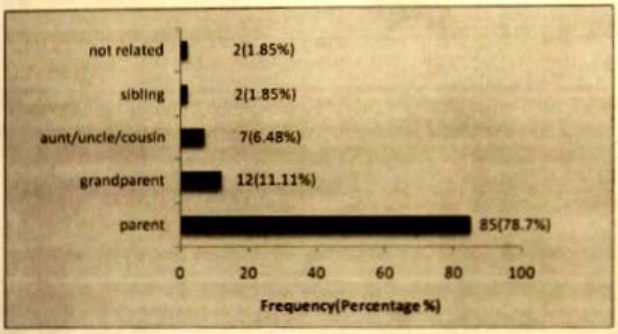


Figure 1. Relationship of caregiver to child

4.2. PREVALENCE OF ANAEMIA AND MALARIA

A total of 15 cases of Malaria were diagnosed amongst the population of 108 children via microscopy, which is the gold standard, with three being symptomatic and 12 being asymptomatic. Prevalence of malaria by microscopy was found to be 13.89% (95%CI = 8.50-21.88), with 16.22% asymptomatic (95%CI = 8.23-23.66) and 8.82% symptomatic (95%CI = 2.75-13.64) as seen in Table 3. Malaria diagnosed by rapid diagnostic test (RDT) was at 18.5% prevalence. Prevalence of anaemia in the population was 10.19% (95%CI 5.69 – 17.56), where anaemia was Haemoglobin level less than 8g/dl.

Table 3. Malaria and anaemia prevalence amongst HIV-positive children at the PML Children's Hospital

	Prevalence (%)	(95% CI)
Malaria (microscopy)	13.89	8.50 - 21.88
Asymptomatic parasitaemia	16.22	8.23 - 23.66
Symptomatic parasitaemia	8.82	2.75 - 13.64
Malaria (rdt)	18.5	12.21-27.08
Anaemia	10.19	5.69 – 17.56

4.3 NUTRITIONAL STATUS

Nutritional status was assessed via anthropometry, dietary diversity and also a history of breastfeeding.

4.3.1 Anthropometry

Anthropometric indices of weight for age, height for age and BMI for age were assessed amongst the study participants. In assessing weight for age, 9.26% (95%CI 5.01 – 16.46) of the children were severely underweight, 13.89% (95%CI 8.50 – 21.88) were moderately underweight making a prevalence of 23.15% for underweight, 73.15% (95%CI 63.92 – 80.73) were within the normal range, and 3.7% (95%CI 1.38 -9.55) were above normal. For the indicator of stunting (height for age), 22.22% (95%CI 15.30-31.13) of the children were severely stunted, 21.3% (95%CI 14.52-30.13) were moderately stunted, and 56.48% (95%CI 46.90 – 65.6) were of normal height for age. Assessing nutritional status using BMI, 5.56% (95%CI 2.49 – 11.92) were severely wasted and 3.7% (95%CI 1.38 – 9.55) were moderately wasted making a prevalence of 9.26% for wasting, 86.11% (95%CI 78.12-91.50) were of normal weight for height, and 4.63% (95%CI 1.92 – 10.74) were overweight. Prevalences of these indicators amongst the study participants are shown in Table 4.

Table 4. Anthropometric indicators of study participants

	Prevalence (%)	(95% CI)
Weight-for-age		
Severe underweight	9.26	5.01-16.46
Moderate underweight	13.89	8.50-21.88
Normal	73.15	63.92-80.73
Overweight	3.70	1.38-9.55
Height-for-age		
Severe stunting	22.22	15.30-31.13
Moderate stunting	21.30	14.52-30.13
Normal	56.48	46.90-65.6
BMI-for age		
Severe wasting	5.56	2.49-11.92
Moderate wasting	3.7	1.38-9.55
Normal	86.11	78.12-91.50
Overweight	4.63	1.92-10.74

4.3.2 Dietary Diversity

Dietary diversity was first measured as a qualitative assessment of access to all the different food groups (total dietary diversity), and then with specific attention to consumption of food groups containing the micronutrients – iron, folate, and vitamins B12 and A.

Participants provided a dietary recall of the preceding 24 hours which was used to identify food groups consumed. There were 17 food groups in all. The presence of each food group was indicated with a score of one, and absence was indicated with a score of zero. The sum total of all the food groups consumed was computed for the total dietary diversity score, and based on findings from the Ghana Demographic Health Survey scores less than 4 out of 17 classified as low dietary diversity, scores from 5 to 10 were classified as medium dietary diversity, and scores over 10 were classified as high dietary diversity. Similarly, scores were computed for the all food groups that were major sources (both plant and animal) of the micronutrients of interest. The micronutrient with the least number of food group sources had five food groups, and the micronutrient with the most food group sources had seven food groups. Thus scores of five to seven were classified as high dietary diversity, scores of two or less were classified as low dietary diversity, and scores of three to four were classified as medium dietary diversity.

Greater than 70% of the children had medium to high dietary diversities when it came to general or total dietary diversity which assesses whether they are eating from across a wide variety of food groups. However, in examining the micronutrients of interest - iron, folate, vitamins A and B12, they had mainly low dietary diversities. About 52% had diets which were moderately diverse in food sources containing folate, 80% of children were consuming foods not diverse with respect to Vitamin B12 sources, less than a third (31%) were consuming foods diverse in iron sources, and more than half (65%) had diets low in diversity

with respect to Vitamin A containing food sources. Proportions of participants and their respective dietary diversities with respect to the micronutrients are shown in Table 5.

Table 5. Dietary diversity of study participants.

Dietary diversity	Prevalence (%)	(95% CI)
Total dietary diversity:		
Low dietary diversity	11.25	5.89-20.40
Medium dietary diversity	73.75	62.88-82.32
High dietary diversity	15	8.64-24.76
Folate:		
Low dietary diversity	47.5	36.68-58.55
Medium dietary diversity	50	39.05-60.94
High dietary diversity	2.5	0.61-9.64
Vitamin B12:		
Low dietary diversity	80	69.63-87.46
Medium dietary diversity	20	12.53-30.37
Iron		
Low dietary diversity	68.75	57.65-78.05
Medium dietary diversity	31.25	21.95-42.35
Vitamin A		
Low dietary diversity	65	53.80-74.76
Medium dietary diversity	32.5	23.04-43.64
High dietary diversity	2.5	0.61-9.64

4.3.3 Breastfeeding Practice

Breastfeeding practice was assessed in the study participants. For those above two years of age, this assessment was mainly retrospective in nature.

About ninety-four percent of children were breastfed as against 5.56% who were not breastfed (Table 6). Reasons for not breastfeeding are shown in Table 6. Eighty-three percent of the six children who were not breastfed were not breastfed because mother was not available, and one child (17%) was not breastfed because mother chose not to breastfeed. Seventy-eight percent of children were exclusively breastfed as against 22% who were mixed fed (Table 6), and of the 78% who were exclusively breastfed, 84% experienced the full six months breastfeeding, while 16% had less than six months of exclusively breastfeeding (Table 6). The median duration of exclusive breastfeeding was about four months.

Table 6. Breastfeeding practice among study participants

	Frequency	Percentage
Breastfeeding Practice		
Breastfed	102	94.41
Not Breastfed	6	5.56
Duration Of Breastfeeding		
6 months and more	67	83.75
Less than 6 months	13	16.25
Feeding option		
Exclusive Breastfeeding	80	78.43
Mixed feeding	22	21.57
Reason for not breastfeeding		
Feeding option chosen	1	16.67
Mother unavailable	5	83.33

4.4 HEALTH KNOWLEDGE AND HEALTH SEEKING BEHAVIOURAL FACTORS

Factors assessed were knowledge of malaria and HIV, malaria prevention practices, and health seeking behaviour. Adequacy of these factors is summarized in Table 7.

Malaria knowledge was assessed using 12 multiple choice questions on the mode of transmission, prevention, vector and vector feeding times, and malaria fatality. Correct answers were scored one, wrong answers were scored zero. Total scores were computed out of 12 and adequacy of knowledge classified as zero to five meaning no knowledge, six to nine meant inadequate knowledge, and more than 10 meant adequate knowledge.

HIV knowledge was assessed with eight TRUE or FALSE questions. Each correct answer had a score of one, and a wrong answer was scored zero. A score of two or less meant no knowledge, three to five meant adequate knowledge, and more than six meant adequate knowledge

To assess malaria prevention practice, participants were asked which ones they practiced without access to the list provided on the questionnaire. The correct ones mentioned were scored one, any not mentioned were not scored, and wrong ones were scored zero. Out of six correct methods, three or less were scored inadequate practice, four or more were scored adequate practice.

Health seeking behaviour was assessed by two questions, one on the first choice of healthcare accessed when sick and the other on the time frame within which health care was accessed (within 24 hours, 24 to 48 hours, 48 to 72 hours, and more than 72 nours) . The optimum was going to a health centre or a community health worker within twenty-four hours. A score of one was assigned to health centre/clinic or community health worker, a score of two was assigned to drug store, and a score of three was assigned to traditional healer or local herbs. In terms of the time frame, a score of one was assigned to access to care within 24 hours, and

all other options were assigned three. Scores of the two questions were summed, and a score of two meant good practice, and three or more meant poor practice.

Overall, more than half (74%) of caregivers had inadequate knowledge on malaria, same as in HIV where 55% of caregivers had inadequate knowledge about HIV. This picture was same for malaria prevention practices with 81% having inadequate practices. However, 56% had adequate health seeking behaviour.

Table 7 Adequacy of health knowledge, malaria prevention practices and health seeking behaviour

	Adequate	Inadequate	None
		N(%)	
Malaria knowledge	12(11.11)	80(74.07)	16(14.81)
HIV knowledge	11(10.19)	59(54.63)	38(35.19)
Malaria prevention practice	20(18.52)	88(81.48)	0
Health seeking behaviour	61(56.48)	47(43.52)	0

4.4.1 Malaria knowledge

Whether caregivers had ever heard of malaria was assessed, knowledge of the vector, mode of transmission and fatality were also assessed, as well as knowledge of malaria prevention methods.

Majority (99%) of caregivers had heard about malaria. Ninety percent knew malaria was fatal when untreated, 95% knew that the vector for malaria was the mosquito, and 94% knew that the mode of transmission was the bite of an infected mosquito (Figure 2). Sixty-seven percent believed they had enough knowledge about malaria, 27% believed they did not have enough information, and 6% did not know if they had enough information about malaria (Figure 3).

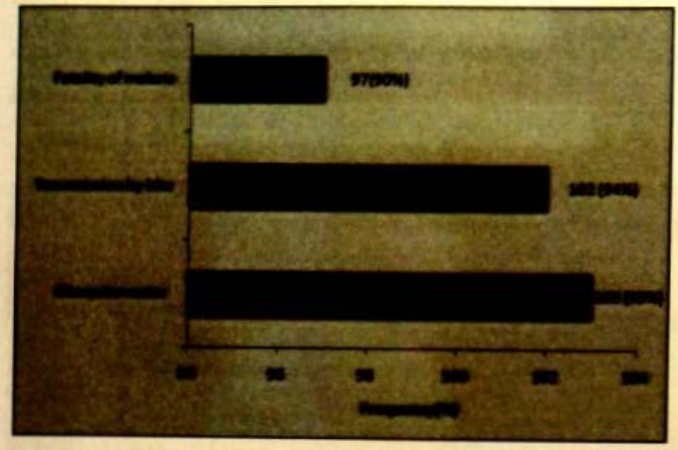


Figure 2. Knowledge about malaria – fatality, mode of transmission and vector

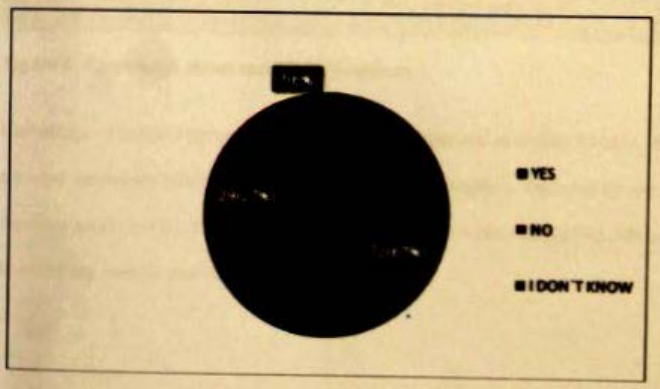


Figure 3. Enough knowledge about malaria

Majority (64%) of caregivers knew fever or high temperature was a sign of malaria. Other signs and symptoms mentioned included vomiting, loss of appetite, yellow eyes (jaundice) which are as shown in Figure 4 below.

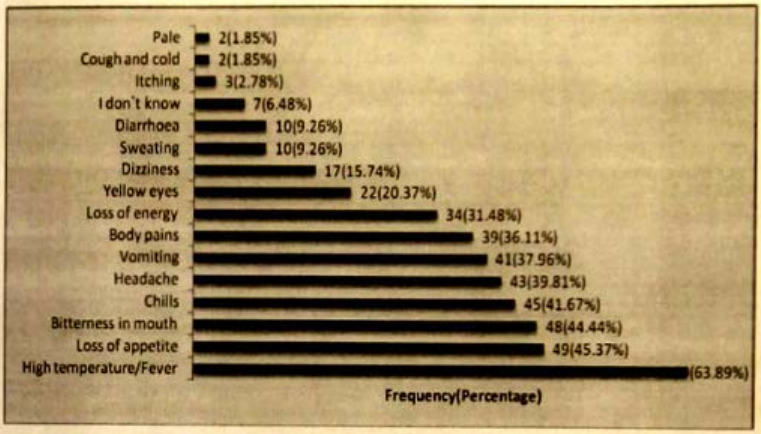


Figure 4. Knowledge about malaria - symptoms

Knowledge of malaria prevention practices are summarized in Figure 5 below. Bed nets was the most commonly mentioned method by 82% of respondents, followed by use of mosquito repellant sprays (54%), and thirdly environmental hygiene practices (52%). About 4% did not know of any malaria prevention practices.

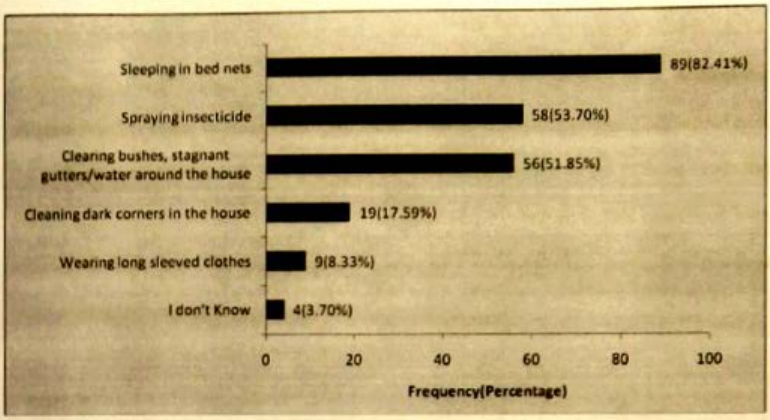


Figure 5. Knowledge about malaria prevention methods

4.4.2 Malaria prevention practices

With respect to utilization of malaria prevention practices, the use and maintenance of insecticide treated mosquito nets, using insecticides to repel mosquitoes, and practicing environmental hygiene to control/clear mosquito breeding areas was assessed.

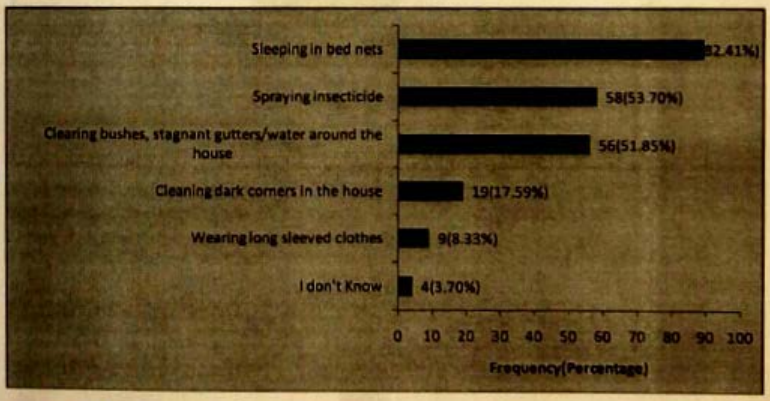


Figure 6. Malaria prevention practices

Both the possession and use of bednets was assessed. 78% (84 out of 108) of households had bednets, 22% did not (Figure 7). Of the 84 households who had bednets, 62% ensured that children were sleeping in nets (76% were children under 5) while the whole household used the bednets in only a minority (38%) (Figure 8). The reasons given by the 24 households that did not have bednets are outlined in Figure 9. Side effects of sleeping in nets mentioned were itching skin and face. The frequency and consistency of the malaria prevention practices mentioned were assessed and presented in Figure 10.

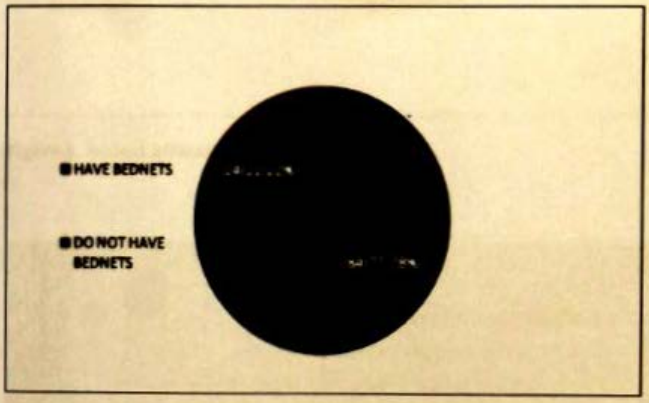


Figure 7. Bednet possession

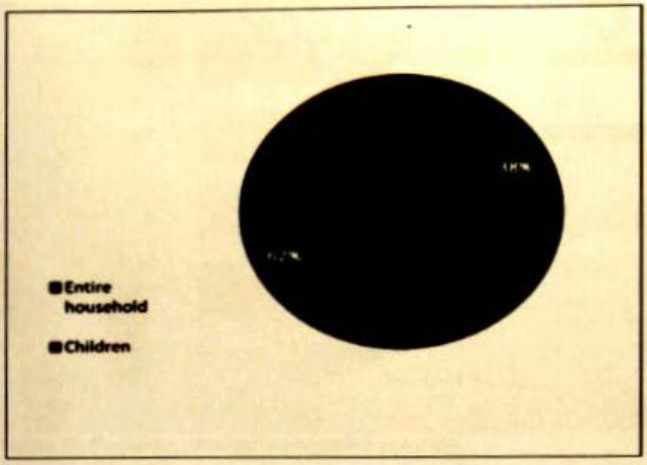


Figure 8. Bednet utilization

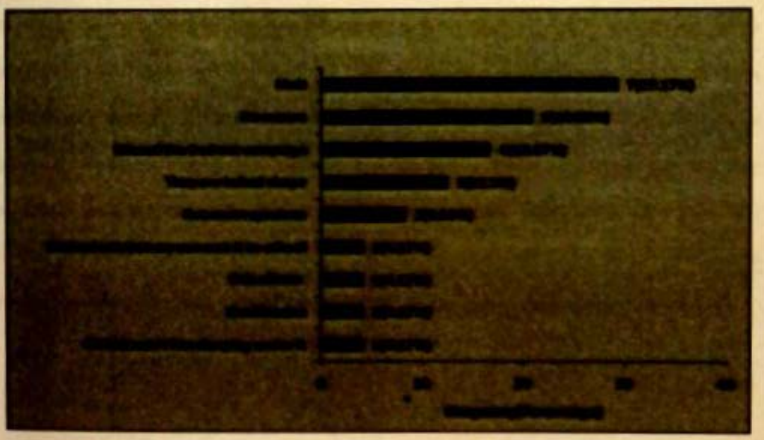


Figure 9. Reasons for not having or using bednets

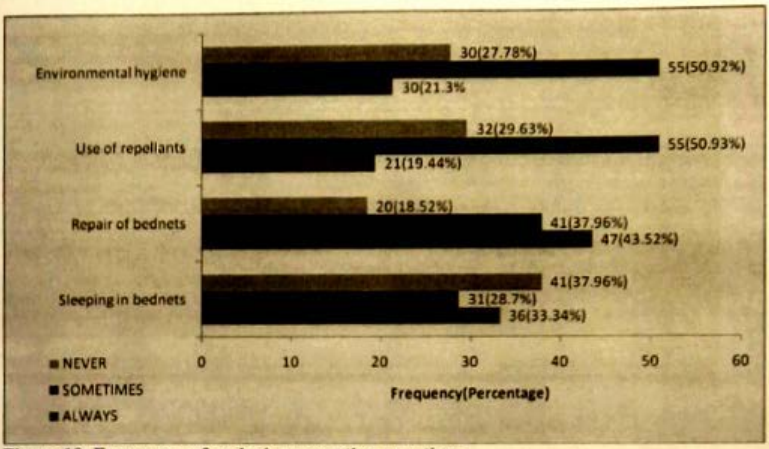


Figure 10. Frequency of malaria prevention practices.

4.4.3 Health seeking behaviour

Health seeking behaviour was assessed with respect to where study participants sought healthcare in the event that they were ill, and the time frame within which they would access healthcare. 65% mentioned the Health Centre or Clinic as their first point of call, 33% mentioned a drug store, about 5% said they would treat themselves with local herbs, none picked the option of traditional medicine which was also presented, and one person said they would do nothing (Figure 11). With respect to the time frame, 52% were going to seek help within forty-eight to seventy-two hours, 38% were going to seek help within twenty-four hours, and 10% were going to wait for at least three days before seeking help (Figure 12).

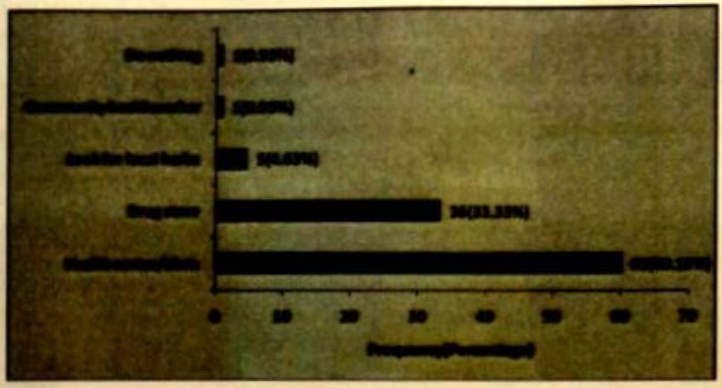


Figure 11. Source of healthcare in the event of suspected malaria

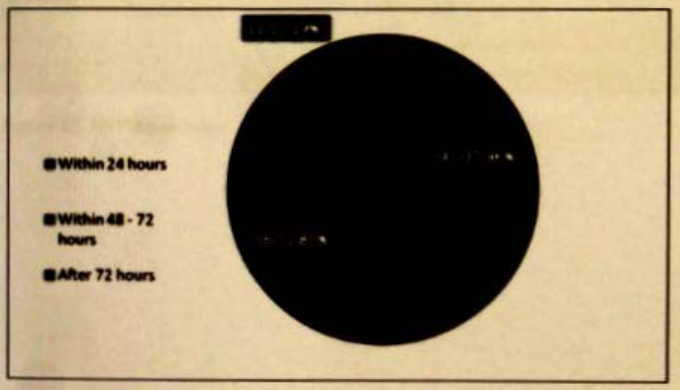


Figure 12. Time frame within which healthcare will be sought

4.4.4 HIV Knowledge

Figure 13 shows the percentages of respondents who believed the statements provided about HIV were true. Majority (99%) knew about the fact that multiple sexual partners increased the risk of getting the infection, however, quite a number had misconceptions about transmission and prevention of HIV.

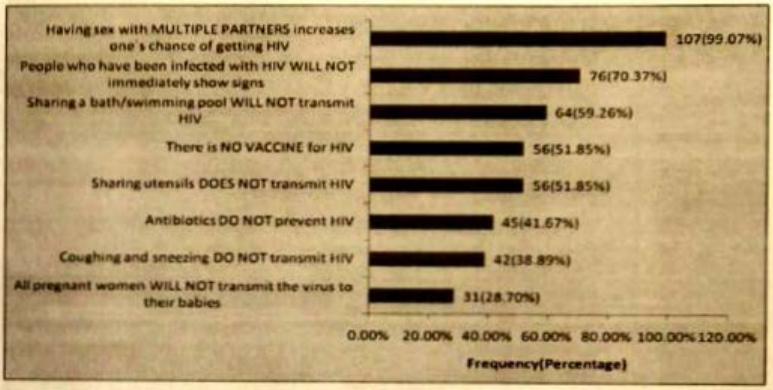


Figure 13. HIV knowledge

4.4.5 HIV Management

Of the 108 HIV-Positive children recruited, 72% were classified as HIV stage 1, 22% were stage 2, and 6% were stage 3. No stage 4 children were recruited into the study. 86% of the children were on anti-retroviral therapy, 14% were not. 65% were on Septrin (cotrimoxazole), 35% were not (Table 8).

Table 8. Proportions of study participants at various levels of HIV staging and management.

Variable	N(%)
ART	
Yes	93(86.11)
No	15(13.89)
SEPTRIN	
Yes	70(64.81)
No	38(35.19)
HIV STAGING	
1	78(72.22)
2	24(22.22)
3	6(5.56)

4.5 FACTORS ASSOCIATED WITH MALARIA

4.5.1 Sociodemographic factors

In assessing the effects of the sociodemographical characteristics of the participants had on co-infection with malaria, there was a significant association between sex and malaria infection. A greater proportion of males (26.56%) had malaria compared to 6.82% of females (COR=0.48, 95%CI =0.14-1.62) as seen in Table 9. There was no significant association between the age of the child, sex, age and educational level of caregiver, or poverty probability with malaria.

Table 9. Bivariate analysis of sociodemographic characteristics and malaria

Variables	Malaria	No Malaria	Fisher's exact	p	COR (95% CI)	p
	N (%)					
Sex of child						
Male(ref)	11(17.19)	53 (82.81)	0.011	**0.009***		
Female	4 (9.09)	40 (90.9)			0.20(0.06-0.74)	**0.016***
Age of child(years)						
< 5(ref)	16(21.05)	60(78.95)	0.340	0.273		
5 to 10	4(18.18)	18(81.82)			1.31(0.37-4.62)	0.67
> 10	0	10(100)				
Sex of caregiver						
Male(ref)	3(37.50)	5(62.50)	0.164	0.151		
Female	17(17)	83(83)			4.48(0.08-2.46)	0.356
Age of caregiver(years)						
15 – 30 (ref)	8(22.22)	28(77.78)	0.593	0.657		
31 - 40	8(21.05)	30(78.95)			0.63(0.18-2.20)	0.466
41 - 60	4(12.12)	29(87.88)			0.41(0.09-1.76)	0.232
Above 60	0	1(100)				
Educational level of caregiver						
None(ref)	1(7.14)	13(92.86)	0.327	0.306		
Primary	7(17.50)	33(82.50)			0.86(0.15 –5.01)	0.864
Secondary	10(25.64)	29(74.36)			1.09(0.19-0.16)	0.922
Post Secondary/ vocational	2(28.57)	5(71.43)			1.00(0.078-1.33)	1.000
Tertiary	0	8(100)			0.86(0.65-1.13)	0.907
Socioeconomic status						
Poor	12(21.82)	43(78.18)	0.460	0.369		
Non-poor	8(15.09)	45(84.91)			0.47(0.15-1.48)	0.196

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.5.2 Nutritional Status

4.5.2.1 Anthropometry

None of the anthropometric indices measured had any significant associations with malaria

(Table 10)

Table 10. Bivariate analysis of anthropometry and malaria

Variables	Malaria	No Malaria	Fisher's exact	p	COR (95% CI)	p
	N (%)					
Anthropometry						
Weight for age:						
Severely underweight(ref)	3(30.00)	7(70.00)	0.241	0.392		
Moderately underweight	2(13.33)	13(86.67)			0.36(0.05-2.68)	0.318
Normal	9(11.39)	70(88.61)			0.30(0.07-1.37)	0.121
Overweight	1(25.00)	3(75.00)			0.78(0.06-10.86)	0.852
Height for age:						
Severely stunted(ref)	4(16.67)	20(83.33)	0.610	0.709		
Moderately stunted	4(17.39)	19(82.61)			1.05(0.22-4.82)	0.947
Normal	7(11.48)	54(88.52)			0.65(0.17-2.45)	0.523
BMI						
Severe wasting(ref)	2(33.33)	4(66.67)	0.068	0.06#		
Moderate wasting	2(50.00)	2(50.00)			2.0(0.15-26.73)	0.600
Normal	11(11.83)	82(88.17)			0.26(0.04-1.63)	0.154
Overweight	0	5(100)				

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.5.2.2. Dietary diversity

Consumption of a diet with medium total dietary diversity was associated with malaria. Children with a medium total dietary diversity score had a reduced odds of malaria (COR 0.24, 95%CI 0.05 – 0.97) which was significant ($p<0.05$) (Table 11).

Table 11 Bivariate analysis of dietary diversity and malaria

Variables	Malaria	No Malaria	Fisher's exact	*p*	COR (95% CI)	*p*
	N (%)					
Dietary diversity						
Total dietary diversity:						
Low dietary diversity(ref)	4(33.33)	8(66.67)	0.124	0.108		
Medium dietary diversity	8(10.67)	67(89.33)			0.24 (0.05-0.97)	**0.046***
High dietary diversity	3(14.29)	18(85.17)			0.33 (0.06-1.85)	0.209
Folate:						
Low dietary diversity(ref)	5(10.64)	42(89.36)	0.218	0.179		
Medium dietary diversity	7(12.73)	48(87.27)			1.23 (0.36-4.15)	0.744
High dietary diversity	2(40.00)	3(60.00)			5.60 (0.74-2.00)	0.094#
Vitamin B12:						
Low dietary diversity(ref)	12(13.95)	74(86.05)	0.637	0.969		
Medium dietary diversity	3(13.64)	19(86.36)			0.97 (0.25-3.80)	0.969
Iron						
Low dietary diversity(ref)	11(15.07)	62(84.93)	0.803	0.829		
Medium dietary diversity	4(11.76)	30(88.24)			0.75 (0.22-2.55)	0.648
High dietary diversity	0	1(100)				
Vitamin A						
Low dietary diversity(ref)	7(10.14)	62(89.86)	0.211	0.184		
Medium dietary diversity	8(22.22)	28(77.78)			2.53 (0.84-7.66)	0.101
High dietary diversity	0	3(100)				

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.5.2.3 Breastfeeding

There was an association between breastfeeding and malaria. Children who were never breast fed had an increased odds of having malaria (COR 7.5, 95%CI 1.63 – 41.46), and this association was significant ($p<0.05$) (Table 12). Whether children were exclusively breastfed or mixed fed was not significantly associated with malaria.

Table 12. Bivariate analysis of breastfeeding and malaria

Variables	Malaria	No Malaria	Fisher's exact	*p*	COR (95% CI)	*p*
	N (%)					
Breastfeeding practice						
Ever breastfed(ref)	12(11.76)	90(88.24)	0.034	**0.008***		
Never breastfed	3(50)	3(50)			7.50(1.36-41.46)	**0.02***
Exclusive breastfeeding practice						
Exclusive breastfeeding(ref)	9(11.25)	71(88.75)	0.718	0.758		
Mixed feeding	3(13.64)	19(86.36)			1.25(0.31-5.06)	0.31

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.5.3 Health knowledge and health seeking behavioural factors

Adequacy of malaria knowledge, malaria prevention practices and health-seeking behaviour had no significant association with malaria (Table 13)

Table 13.Bivariate analysis of behavioural factors and malaria

Variables	Malaria N (%)	No Malaria N (%)	Fisher's exact	p	COR (95% CI)	p
Knowledge about Malaria						
No knowledge (ref)	4(25)	12(75)	0.380	0.352		
Indequate	10(12.50)	70(87.50)			0.43 (0.12-1.59)	0.205
Adequate	1(8.33)	11(91.67)			0.27 (0.03-2.83)	0.276
Malaria prevention practice						
Inadequate practice (ref)	12(13.64)	76(86.36)	1.000	0.874		
Adequate practice	3(15.00)	17(85.00)			1.12 (0.28-4.40)	0.874
Health seeking behaviour						
Adequate practice(ref)	9(14.75)	52(85.25)	0.088	0.767		
Inadequate practice	6(12.77)	41(87.23)			0.84 (0.31-2.25)	0.725

$p<0.05$ = statistically significant

COR – Crude odds ratio

4.5.4 HIV Management

Children who were not on Septrin had an increased odds of malaria (COR 3.31, 95%CI =1.08-10.17), which was a significant association ($p<0.05$). Bivariate analysis of other levels of HIV staging and management are summarized in Table 14 below.

Table 14. Bivariate analysis of HIV management and malaria.

Variables	Malaria	No Malaria	Fisher's exact	*p*	COR (95% CI)	*p*
	N (%)					
HIV Staging						
1(ref)	9(11.54)	69(88.46)	0.162	0.149		
2	6(25.00)	18(75.00)			2.55(0.80-8.12)	0.112
3	0	6(100)				
Use of Co-trimoxazole						
Yes(ref)	6(8.57)	64(91.43)	0.042	**0.03***		
No	9(23.68)	29(76.32)			3.31(1.08-10.17)	**0.037***
Antiretroviral therapy						
Yes(ref)	13(13.98)	80(86.02)	1.000	0.947		
No	2(13.33)	13(86.67)			0.95(0.19-4069)	0.947

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.6 FACTORS ASSOCIATED WITH ANAEMIA

4.6.1 Prevalence of Anaemia

Anaemia in this study was haemoglobin levels less than 8g/dl as prescribed for malaria associated anaemia by the Ghana Malaria Indicator Survey (GSS, 2017). Mean haemoglobin in the population was 10.28g/dl (95%CI 9.91 – 10.66). Prevalence of anaemia in the population was 10.19% (95%CI 5.69 – 17.56). Distribution of the cases of anaemia can be found in Table 15. Prevalence of anaemia was highest in children under five and in males, however there was no significant association between age and sex and anemia.

Table 15. Incidence of anaemia by age and sex

Variables	Anaemia	No Anaemia	Fisher's exact	*p*	COR (95% CI)	*p*
Sex of child	N (%)					
Male (ref)	8(12.50)	56(87.50)	0.520	0.337		
Female	3(6.82)	41(93.18)			1.95 (0.49-7.81)	0.344
Age of child (years)						
Under 5 (ref)	9(11.84)	67(88.16)	0.681	0.609		
5 - 10	1(4.55)	21(95.45)			2.82 (0.34-23.58)	0.338
Over 10	1(10.00)	9(90.00)			1.21 (0.14-10.69)	0.865

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.6.2 Nutritional Status and Anaemia

There was also no significant association between anaemia and anthropometric indices (Table 16), anaemia and dietary diversity (Table 17) and anaemia and exposure to breastfeeding (Table 18).

Table 16 Bivariate analysis of anthropometry and anaemia

Variables	Anaemia N (%)	No anaemia	Fisher's exact	*p*	COR (95% CI)	*p*
Anthropometry						
Weight for age:						
Severely underweight(ref)	3(30.00)	7(70.00)	0.189	0.165		
Moderately underweight	1(6.67)	14(93.33)			6(0.52-68.72)	0.150
Normal	7(8.86)	72(91.14)			4.4(0.93-20.96)	0.062#
Overweight	0	4(100)				
Height for age:						
Severely stunted(ref)	6(25.00)	18(75.00)	0.031	**0.024***		
Moderately stunted	1(4.35)	22(95.65)			7.33 (0.81-66.63)	0.077
Normal	4(6.56)	57(93.44)			4.75 (1.21-18.72)	**0.026***
BMI						
Severe wasting(ref)	1(16.67)	5(83.33)	0.047	0.078		
Moderate wasting	1(25.00)	3(75.00)			0.6(0.03-13.58)	0.748
Normal	7(7.53)	86(92.47)			2.45 (0.25-24.04)	0.440
Overweight	2(40.00)	3(60.00)			0.3(0.02-4.91)	0.398

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

Table 17. Bivariate analysis of dietary diversity and anaemia

Variables	Anaemia	No anaemia	Fisher's exact	*p*	COR (95% CI)	*p*
	N (%)					
Dietary diversity						
Total dietary diversity:						
Low dietary diversity(ref)	1(8.33)	11(91.67)	0.877	0.783		
Medium dietary diversity	7(9.33)	68(90.67)			0.88(0.10-7.89)	0.911
High dietary diversity	3(14.29)	18(85.71)			0.55(0.05-5.91)	0.618
Folate:						
Low dietary diversity(ref)	5(10.64)	42(89.36)	0.619	0.740		
Medium dietary diversity	5(9.09)	50(90.91)			1.19(0.32-4.39)	0.794
High dietary diversity	1(20.00)	4(80.00)			0.47(0.04-5.14)	0.541
Vitamin B12:						
Low dietary diversity(ref)	11(12.79)	75(87.21)	0.115	0.077		
Medium dietary diversity	0	22(100)				
High dietary diversity						
Iron						
Low dietary diversity(ref)	8(10.96)	65(89.04)	1.00	0.891		
Medium dietary diversity	3(8.82)	31(91.18)			1.27(0.32-5.13)	0.735
High dietary diversity	0	1(100)				
Vitamin A						
Low dietary diversity(ref)	7(10.14)	62(89.86)	1.00	0.829		
Medium dietary diversity	4(36.36)	32(32.99)			0.90(0.25-3.32)	0.878
High dietary diversity	0	3(100)				

* *$p<0.05$ = statistically significant*

COR – Crude odds ratio

Table 18 Bivariate analysis of breastfeeding and anaemia

Variables	Anaemia	No Anaemia	Fisher's exact	*p*	COR (95% CI)	*p*
	N (%)					
Breastfeeding practice						
Ever breastfed(ref)	10(90.91)	92(94.85)	0.484	0.589		
Never breastfed	1(9.09)	5(5.15)			0.54 (0.6-5.13)	0.594
Exclusive breastfeeding practice						
Exclusive breastfeeding(ref)	8(80.00)	72(78.26)	1.000	0.899		
Mixed feeding	2(20.00)	20(21.74)			1.11 (0.22-5.65)	0.899

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.6.3 Malaria and Anaemia

Normal haemoglobin was associated with a reduced odds of having malaria (COR 0.69, 95%CI=0.1 – 3.59), which was significant (Table 19).

Table 19. Bivariate analysis of anaemia and malaria

Variables	Malaria	No Malaria	Fisher's exact	*p*	COR (95% CI)	*p*
	N (%)					
Hb						
Anaemia(ref)	5(45.45)	6(54.55)	0.029	**0.015***		
Normal	15(15.46)	82(84.54)			0.69(0.14-3.59)	**0.023***

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.6 SUMMARY OF BIVARIATE ANALYSIS

Simple logistic regression was used in determining the exposure associations between independent variables of interest and malaria as has been presented previously.

All the significantly associated factors are summarized in Table 20 below.

Poverty probability as a proxy for socioeconomic status was not significantly associated with malaria as an outcome, but was included in the multivariate analysis.

Table 20. Summary of Bivariate analysis – factors significantly associated with malaria.

Variables	COR(95% CI)	*p*
Malaria		
Sex (Female)	0.20 (0.06-0.74)	**0.016***
Normal Hb	0.69 (0.14 – 3.59)	**0.023***
Never breastfed	7.50 (1.36-41.46)	**0.020***
Total dietary diversity(medium)	0.24 (0.05-0.97)	**0.046***
Septrin (non-exposure)	3.31 (1.08-10.17)	**0.037***
Poor	2.13(0.68 – 6.72)	0.196

** $p<0.05$ = statistically significant*

COR – Crude odds ratio

4.7 MULTIVARIATE ANALYSIS

Multivariable logistic regression was run on the factors that were found to have significant association with malaria after the univariate analysis. The multivariable analysis was run while controlling for sex and age and poverty. Factors found to be significantly associated with malaria were poverty, children who were never breastfed, a medium dietary diversity and non-exposure to septrin (Table 21).

Sex and normal haemoglobin were not significant when breastfeeding, septrin and dietary diversity were controlled for.

Children who had never been breastfed had an increased odds of malaria (AOR=32.19,, 95%CI = 2.99 – 345.89)

Medium dietary diversity was associated with a reduced odds of malaria (AOR=0.11, 95%CI = 0.02 – 0.63).

Non-exposure to septrin was associated with an increased odds of malaria (AOR=7.12, 95%CI = 1.56-32.43).

Poverty was significantly associated with an increased odds of malaria (AOR=6.52, 95%CI = 1.12 – 37.78)

Table 21. Multivariate analysis of factors associated with malaria in HIV-positive children

Variables	COR(95% CI)	*p*	AOR(95%CI)	*p*
Sex (Female)	0.20 (0.06-0.74)	**0.016***	0.51(0.12-2.18)	0.359
Normal Hb	0.69 (0.14 – 3.59)	**0.023***	0.83(0.10-6.56)	0.856
Never breastfed	7.50 (1.36-41.46)	**0.020***	32.19(2.99-345.89)	**0.004***
Total dietary diversity(medium)	0.24 (0.05-0.97)	**0.046***	0.11(0.02-0.63)	**0.013***
Septrin (non-exposure)	3.31 (1.08-10.17)	**0.037***	7.12(1.56-32.43)	**0.011***
Poor	2.13(0.68 – 6.72)	0.196	6.52(1.12 – 37.78)	**0.037***

** $p<0.05$ = statistically significant* *COR – Crude odds ratio* *AOR – Adjusted odds ratio*

CHAPTER FIVE

5.0 DISCUSSION

5.1. SOCIODEMOGRAPHIC CHARACTERISTICS OF THE POPULATION

The preponderance of females amongst caregivers follows the norm in Africa where most of the care work concerning children in the home is by women (Kassam, Collins, & Sekiwunga, 2016; Kassam, Sekiwunga, Collins, Tembe, & Liow, 2016; Kassam, Sekiwunga, MacLeod, Tembe, & Liow, 2016; Kidman & Thurman, 2014; Thandar, Kyaw, Jimba, & Yasuoka, 2015). Numerous studies have revealed that over two-thirds of primary caregivers in households with HIV-positive individuals were women. However, whereas in some parts of Southern Africa the disease is known as the grandmother's disease because a lot of children are orphaned by HIV/AIDS and become the wards of their grandmothers, in this study majority of caregivers were parents to the children (Ofunne, 2014; UNAIDS & UNIFEM, 2008). The introduction of anti-retroviral therapy has made HIV a chronic disease and as such more and more parents are able to survive and care for their children, as in most other acute illnesses in childhood where parents are the primary caregivers (Chuma et al., 2007; Mitiku & Assefa, 2017; Thandar et al., 2015; Wambui et al., 2018). While children can get HIV from other sources such as sexual abuse, tainted blood transfusions or medical procedures and intravenous drug use also in settings of child abuse, the main mode of transmission is vertical, so for the most part, it is assumed that most of the children in the study were infected either in-utero, perinatally or through breastmilk. The varying educational levels are also similar in other studies that were carried out in urban areas – very few people have no education at all, most have primary and secondary education, with a few having tertiary levels of education (Kassam, Collins, & Sekiwunga, 2016; Kassam, Sekiwunga, MacLeod, et al., 2016; Mitiku & Assefa, 2017; Thandar et al., 2015; Wambui et al., 2018)

5.2. PREVALENCE OF MALARIA

Prevalence of malaria in HIV positive children recruited into the study was higher than the pooled prevalence of 9% in sub Saharan African children found by (Naing et al., 2016) but falls within the range of 1.2 – 31% amongst children of all ages compiled from a systemic review by Kwenti (2018) on malaria in HIV positive children in sub Saharan Africa. It was also higher than a prevalence of 3.03% reported by a study in Burkina Faso which looked at all children from newborns to 18 years of age (Sangarei et al., 2015), but lower than a prevalence of 31% reported by (Onankpa et al., 2017) amongst children from one to seventeen years in Nigeria, both of which still fall within the range given by Kwenti (2018). Globally, under-5 mortality contributes to more than 50% of mortality in children under 15years of age. In 2018 5.3million out of 6.2million children under 15 years who died were under-5. Malnutrition and deaths from preventable infectious diseases made up a majority of these deaths (World Health Organization, 2018a). For this reason there is a lot of data on indicators of child health and nutrition in this age group and it is within this context that data obtained from participants in this study was compared to national standards. The Ghana Malaria Indicator Survey (GMIS) (Ghana Statistical Service, National Malaria Control Programme, & National Public Health Reference Laboratory, 2017) gives a malaria prevalence of 21% amongst all children under 5 in Ghana. Looking at the age and sex distribution this study found a prevalence of 14% amongst HIV positive children under five which is lower than the GMIS figure quoted. This lower prevalence may be attributable to the fact that the HIV-positive children are routinely on septrin, which is known to be antimalarial and actually has a protective effect on malaria morbidity in HIV-positive adults (Jegede et al., 2017; Manyanga et al., 2014; Van Geertruyden, 2014).

There was a higher prevalence of asymptomatic parasitaemia. Symptomatic parasitaemia was defined as parasitaemia with the presence of fever in the two weeks preceding the survey, as

described in the 2016 Ghana Malaria Indicator Survey (GSS, 2017). The higher prevalence of asymptomatic parasitaemia is in agreement with literature which describes people (both children and adults but especially in adults) in endemic or high transmission zones as harbouring malaria parasites without showing symptoms as such they may show up in clinic for an illness, and malaria parasitaemia is picked up as an incidental finding and they are diagnosed and treated This actually increases transmission rates as well as the risk of complications such as severe malaria, cerebral malaria and anaemia (Kwenti, 2018; Manyanga et al., 2014). The increased transmission is due to the idea that they form a hidden reservoir from which parasites are picked up to others who may be more vulnerable and might then show symptoms, and this forms the basis for periodic chemoprophylaxis amongst vulnerable groups like pregnant women and children (Doolan, Dobano, & Baird, 2009; Egbewale, Akindele, Adedokun, & Oyekale, 2018; Kwenti, 2018; Maziarz et al., 2018; Onyenekwe, Ilika, & Ezeani, 2014; Simon-Oke, 2017; Sumari et al., 2017; Town, Eke, Chigbu, & Nwachukwu, 2006).

Prevalence of malaria by RDT was higher than that diagnosed by microscopy. This was expected and is actually the norm across malaria prevalence studies that use both methods, including the Ghana Malaria Indicator Survey (GSS, 2017). Microscopy visualizes the parasites in a blood film, while the RDT diagnoses malaria via an antigen-antibody reaction. The RDT has been impregnated with a *P. falciparum* specific antibody which reacts with the antigen in the blood sample being tested. This antibody can remain in the blood for a month after the parasite has been cleared from the blood, meaning an RDT will give a positive result during this time. RDT alone, when used for prevalence studies, gives higher prevalence compared to microscopy as a result of this (Boyce, Menya, Turner, Laktabai, & Prudhomme-O'Meara, 2018; Megnekou et al., 2018; Orish, De-Gaulle, & Sanyaolu, 2018). Cases confirmed by microscopic diagnosis were used as the definitive diagnosis of malaria in this

study since that is the gold standard for malaria diagnosis according to the Ghana Health Service (National Malaria Control Programme, 2015) .

5.3 NUTRITIONAL STATUS.

5.3.1 Anthropometry

Undernutrition in children increases the risks of contracting common infections, increases the frequency and severity of these infections, increases the risks of complications and then delays recovery, further inhibiting the child's capacity for optimum growth and development in a vicious cycle of undernutrition and disease (M. de Onis, Blossner, Borghi, Frongillo, & Morris, 2004; Kwabla, Gyan, & Zotor, 2018; UNICEF, 2019). HIV is associated with malnutrition – weight loss and undernutrition are common - and hasten the disease progression thereby increasing morbidity and mortality. Thus the vicious cycle of underweight and disease where the lack of good nutrition impairs the body's caloric and immune capacity to fight disease as the disease has deleterious effects on food intake, nutrient utilization and immunity as well as antiretroviral drug metabolism, is perpetuated. This has been found to be true in several studies in both children and adults (Heller & Shattuck, 1997; Kimani-Murage et al., 2011; Lodha & Kabra, 2015; Martín-Cañavate et al., 2018; Moolasart, Chottanapund, Ausavapipit, & Ampornareekul, 2017; Ndirango, Wariero, Sachs, Masibo, & Deckelbaum, 2011; Penda, Eboumbou Moukoko, Nolla, Evindi Abomo, & Koki Ndombo, 2018; Poda et al., 2017; Sunguya et al., 2014, 2011; UNICEF, 2016). Various levels of stunting and underweight amongst HIV-positive children have been measured across the world, some as high as 62% (Lodha & Kabra, 2015; Martín-Cañavate et al., 2018; Moolasart et al., 2017; Penda et al., 2018; Sunguya et al., 2014). This is explained by the fact that the interaction between HIV and malnutrition is influenced by food insecurity, wars, famine, low socio-economic status disease stage, associated comorbidities and the different

antiretroviral medications, and these vary in different populations and countries (Grobler, Siegfried, Visser, Mahlungulu, & Volmink, 2013; Lodha & Kabra, 2015). Under-five prevalence of underweight (reflects both acute and chronic malnutrition) and stunting (reflects chronic malnutrition) are higher than national figures amongst the general population but prevalence for wasting (reflects acute malnutrition) is the same, which could be explained by the fact that HIV is a chronic disease and is associated with malnutrition (Statistical Service Accra, 2015; World Health Organization, 2010). Total prevalence of underweight is within the range considered medium (20 – 29%) by the WHO, wasting is considered acceptable (5 – 9%), and stunting is considered high (40% and more) (Mercedes de Onis et al., 2018; World Health Organization, 2010). Again, since stunting is an indicator of chronic malnutrition, this implies that, the nutritional status of the population could be attributed to the fact that they have a chronic disease that is known to be associated with malnutrition (Lodha & Kabra, 2015; Moolasart et al., 2017; World Health Organization, 2010)

5.3.2 Dietary diversity

Dietary diversity scores qualitatively measure access to and consumption of nutrients just by their mere presence in the diet, and studies have shown that high scores are related to adequacy of nutrients in the diet, with the reverse also being true (Frempong & Annim, 2017; Poda et al., 2017; Sunguya et al., 2014).

More than seventy percent of the children had medium to high total dietary diversity scores. However low dietary diversities of the micronutrients of interest - iron, folate, vitamins A and B12, was uncovered. Thus although they were consuming a wide variety of foods, the food choices were not sources of the micronutrients of interest. It is recommended that

children consume at least three food groups (four for children that are not being breastfed) (Arimond & Ruel, 2004; Statistical Service Accra, 2015; UNICEF, 2013), thus most of these children were meeting the total dietary diversity requirements, however their diets were likely to be deficient in the micronutrients of interest.

Micronutrient deficiency is a major contributing cause of childhood morbidity and mortality. Micronutrients are required in small amounts, but have huge impact on the body's functions. Iron, Folate and Vitamin B12 are necessary for erythropoiesis and maintaining the blood, thus deficiency of any of them leads to anaemia. There was however no association found between dietary diversity and anaemia, or any of the anthropometric indicators of malnutrition. Vitamin A is an integral component of immune function and maintaining the epithelial tissue, deficiency compromises the child's immunity and is a major cause of blindness in children, especially those who are malnourished (Black et al., 2008, 2013; Frempong & Annim, 2017; Statistical Service Accra, 2015). From the data therefore, most of the children were consuming diets that were not nutritionally adequate which could lead to malnutrition and therefore impair their ability to withstand the effects of HIV. From the GDHS 2014, maternal education and household wealth were associated with dietary diversity, however this was not a conclusion arrived at in this study.

5.3.3 Breastfeeding

Practice of breastfeeding was comparable to the GDHS 2014 which finds that almost all children in Ghana (98%) are breastfed at some point in their life (Statistical Service Accra, 2015). Exclusive breastfeeding was predominant and higher than global figures from WHO which quote an exclusive breastfeeding prevalence of 40% (World Health Organization, 2018b). However, this can be explained by the PMTCT and EMTCT campaigns which stress exclusive breastfeeding in HIV positive mothers to prevent transmission of the disease through breastmilk, if the transmission has not occurred peri-natally or in-utero, so they will

actually be more likely to breastfeed than the general population. Currently, with the ART guidelines ensuring all pregnant women are immediately started on treatment when found HIV positive, the risk of transmitting has reduced, while the infant` s survival has increased even with mixed feeding (Ministry Of Health, 2016; World Health Organization & United Nations Children's Fund, 2016). Studies have found that exclusive breastfeeding actually reduced the incidence of adverse health outcomes and diarrhoeal infections in both HIV positive children and children who were not HIV positive (Becquet et al., 2007; Rollins et al., 2008; Rollins et al., 2013; Taha et al., 2006).

5.4 Health knowledge and health seeking behavioural factors

Health knowledge about malaria and HIV was generally inadequate in the population when a composite of knowledge of transmission, prevention, and management of the individual diseases were put together. Most caregivers however knew the common symptom of malaria was fever, they also knew that mosquito bites transmitted malaria, that bed nets were an important personal protection method, and that malaria could be fatal. This has been reflected in other studies where despite general paucity of health knowledge, these basic facts about malaria were known (Mitiku & Assefa, 2017). Overall, more than half of caregivers had inadequate knowledge on malaria and also on HIV. This picture was same for malaria prevention practice. This is no surprise since it is generally expected and has been found that adequacy of health-promoting practices will depend on having knowledge in the first place (Chuma et al., 2007; Wambui et al., 2018). However, the inadequacy of knowledge and personal preventive measures did not translate into inadequate health seeking behaviours. Majority had adequate health seeking behaviour which was defined as seeking help from a health center or community healthworker within 24 hours of illness. Health seeking practices in this population was similar to that in other countries in the developing world – majority sought help within the first 24 hours of the illness. Also, caregivers sought help first from

health centres, mobile clinics and community health workers. Drug stores were also a common source of help. Minority of caregivers did nothing or used local herbs and traditional medicines both in this study and in other studies (Kassam, Sekiwunga, Collins, et al., 2016; Kassam, Sekiwunga, MacLeod, et al., 2016; Thandar et al., 2015).

5.5 Factors associated with Malaria.

Factors associated with increased odds of malaria were poverty and non exposure to septrin. History of breastfeeding and a medium dietary diversity were protective of malaria.

5.5.1 Sociodemographic characteristics

From this study, females had reduced odds of malaria but this was not significant under the multivariate analysis. A Differences in exposure to malaria between the sexes has been related to gender roles in adults, studies in children were not found (Diiro et al., 2016; MEASURE Evaluation, 2017; Woldu & Haile, 2015) No such studies were found in children.

The GMIS 2016 (GSS, 2017) found that malaria prevalence decreases as mother's level of formal education increases from 30% for children whose mothers had no formal education to 5% among children whose mothers had secondary or higher levels of education. Also, malaria prevalence was found to decrease with increasing wealth quintile form 37% to 2% between children in the highest and lowest wealth quintiles respectively. This was not replicated in this study however probability of poverty as a proxy for socioeconomic status was found to be significantly associated with malaria when sex, age, breastfeeding and use of cotrimoxazole had been controlled for in the multivariate analysis. Poorer households may not have bednets or may not utilize a bed net perhaps because they did not have the space to hang one freely, or had no means of dealing with the heat it caused; these were the most common reasons for not having bed nets, along with missing the bednet campaigns which provided and hang free bednets for selected communities in the country. Bed nets are also

provided free of charge at child welfare clinics when mothers present with their children at 18 months. Households which miss or do not have access these distribution avenues will have to buy bed nets, which will explain why poorer households may be more likely not to possess bed nets. (GSS, 2017). Several studies across the developing world have shown that affordability, weather conditions (heat) and perception of side effects affect bed net utilization (Bernard et al., 2009; Ng'ang'a et al., 2009; Yohannes et al., 2000) Possession and utilization of bednets however compared favourably with the 2016 GMIS which found that about two thirds of households in Ghana owned at least one bednet, an indication that the National Malaria Control Programme Strategic Plan (Awine, Malm, Bart-Plange, Silal, & Byass, 2017) may be reaching its target which aims to achieve universal coverage with LLINs, defined as one net for every two people. Poorer households in this study were also found to have increased odds of inadequate malaria prevention practices. Low socioeconomic status is associated with illiteracy and low income and has been found to affect the knowledge and adequacy of knowledge and practice of positive childcare habits such as feeding, accessing healthcare and monitoring of wellbeing (Bhakta & Ganesh-Kumar, 2014; Case et al., 2002; Case & Paxson, 2002; Heck & Parker, 2002; Mangrio et al., 2011). It affects financial access to food, bed nets and healthcare(Bernard et al., 2009; GSS, 2017; Ng'ang'a et al., 2009). It influences child feeding practice in terms of feeding frequency and diversity of food (Amugsi et al., 2014; Kimani-Murage et al., 2011; Lodha & Kabra, 2015; Martín-Cañavate et al., 2018; Sunguya et al., 2014) . All these influences ultimately influence morbidity and mortality in childhood. Malaria is known as a disease of poverty, and this study showed a significant relationship between malaria and poverty.

5.5.2 Nutritional Status

5.5.2.1 Anthropometry

This study found no associations between malaria and any of the indicators for malnutrition which is similar to findings in a malaria-endemic region in sub-Saharan Africa (Deribew et al., 2010; Müller, Garenne, Kouyaté, & Becher, 2003) however it is known that malnutrition contributes to an increased susceptibility to infectious diseases , and several findings in current literature have found that stunting and wasting are associated with an increased incidence of malaria both in HIV-positive and uninfected children of all ages. (Arinaitwe et al., 2012; Deen, Walraven, & von Seidlein, 2002; Ehrhardt et al., 2006)

5.5.2.2 Dietary Diversity

This study found that a medium dietary diversity was significantly associated with a reduced odds of getting malaria. Literature showed a significant association between a high dietary diversity and good nutritional status. Since it is known that good nutritional status reduces susceptibility to infectious disease, an inference can be made that dietary diversity can influence malaria morbidity through nutritional status (Onyango, 2003; Pérez-Escamilla et al., 2009; Torheim et al., 2004; Walingo & Ekesa, 2013). However this presents an avenue for more research.

5.5.2.3 Breastfeeding

Breastfeeding was protective against malaria, with children who had never been breastfed having a significantly increased odds of malaria. It is known that breastfed children are healthier and less at risk for frequent infections, malnutrition and generally grow better than children who are not breastfed (Horta & Victora, 2013b, 2013a). These benefits have been found to outweigh the risks of transmitting HIV to newborns by their HIV-positive mother, hence a revision of feeding guidelines in HIV positive mothers from AFASS feeding to exclusive breastfeeding as far as it is possible. This is generally accepted especially in

developing countries where replacement feeding is often culturally unacceptable and expensive (Doherty, T., Chopra, M., Nkonki, L., Jackson, D., & Greiner, 2006; T Doherty, Chopra, Jackson, Goga, & Colvin, 2007; Leshabari et al., 2012; Suryavanshi et al., 2003a).

5.5.3 Health knowledge and health seeking behavioural factors

It is known that positive knowledge is directly proportionate to the care of children (Bhakta & Ganesh-Kumar, 2014; Case & Paxson, 2002) and this is true also in the case of children with HIV. It is therefore thought that improving knowledge on HIV will improve the self-efficacy of caregivers, and therefore help to improve outcomes of HIV-positive children (Ofunne, 2014). As with HIV, it is expected that malaria knowledge should affect the practice of prevention methods which would translate into better care for children. Malaria knowledge and prevention practices was however not significantly associated with the cases of malaria seen in the population. More needs to be done especially in the area of behaviour change communication which is known to have yielded results in places like Uganda in reducing malaria prevalence rates in certain communities (Mwanje, 2013).

5.5.4 HIV Management

Septrin provided a protective effect against malaria. This is proven. Cotrimoxoazole is an antibiotic with anti-parastic effects, which is effective also against the *P. falciparum* parasite.HIV patients are put on Septirn to ward off opportunistic infections (Jegede et al., 2017b; Manyanga et al., 2014; Suthar, Granich, Mermin, Annelies, & Rie, 2012; J.-P. Van Geertruyden, 2014). Recommendations are that although it could be stopped when the patient's immunity is optimum, there is room for continuation in low-income areas where there is constant exposure to pathogens, malnutrition and poor healthcare systems, as such in a place like Ghana, once HIV is suspected, Septrin is started and maintained (GHANA AIDS COMMISSION, 2013; World Health Organisation, 2013)

5.6 Factors associated with Anaemia

Anaemia prevalence in the study population is lower than literature from Nigeria (Sanyaolu et al., 2013) where there was a prevalence of 25.8% in children co-infected with HIV and malaria. When the population was distributed by age, prevalence in children under five was higher than the prevalence of 7% quoted by the Ghana Malaria Indicator Survey 2016 (GSS, 2017) amongst children under five years in the general population. A study in Ghana (Tay et al., 2015) found a higher prevalence of anaemia in HIV positive adults than in the general population, and was replicated in Nigeria, Mozambique, and Ethiopia in both children and adults as presented in the meta-analysis by Kwenti (2018). Anemia was also not associated with dietary diversity or anthropometric indices or HIV management. This was unexpected because anaemia in children is usually associated with malnutrition due to lack of nutritionally adequate diets and recurrent or chronic illnesses (Naing et al., 2016). However, another study in pre-schoolers in Ghana found that other factors such as birth interval and poverty also predicted anaemia in children (Saaka & Galaa, 2017). Since the prevalence compared to that amongst the HIV positive population was lower, it is possible that there were other factors at play that were not investigated by this study, or the children in this population are of better nutritional status than expected in the HIV positive population. They however do have a chronic illness associated with anaemia (Manyanga et al., 2014; Naing et al., 2016) thus the higher prevalence of anaemia in this population compared to the general population is expected.

5.7 LIMITATIONS OF THE STUDY

Breastfeeding history was retrospective for some caregivers and as such the information is at risk of recall bias. In a few cases, some mothers were deceased as such breastfeeding history could not be given or if given would be unreliable.

Caregivers who were employed or had school aged children could also not give a complete twenty four hour dietary recall.

As a descriptive study, the larger the sample size, the more reliable and precise the results. This could explain why known associations were not found significant in this study.

HIV is associated with guilt and stigma especially in the case of caregivers who are the parents of the HIV positive children. They may therefore provide answers that they think paints them in a more favourable light in order to appeal to the interviewer. Results may therefore not be a true reflection of the population as a result of respondent bias.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Prevalence of malaria HIV coinfection was within the range provided in literature.

Nutritional status of HIV positive children was lower than literature reports for the general population, especially among the under-five age group, and underweight was associated with higher levels of anaemia.

Factors associated with HIV malaria coinfection were poverty, the use of Co-trimoxazole, history of breastfeeding and a medium dietary diversity. Children with malaria had an increased odds of coming from a poorer household. The use of Co-trimoxazole, history of breastfeeding and a medium total dietary diversity were protective against malaria.

There are disparities between knowledge and practices on malaria prevention amongst caregivers confounded by socioeconomic status, with poorer households having an increased odds of not having adequate malaria prevention methods such as having bednets.

6.2 RECOMMENDATIONS

Nationwide studies by National HIV/AIDS and Malaria Programs using the ART clinics as a source of information for prospective cohort studies on malaria, nutritional status and anaemia to establish a database for Ghana.

It is also recommended that Malaria Control Programs should intensify the its activities with respect to education on malaria and nutrition, and provision of bednets again in tandem with the National HIV programs, using special clinics as a point of contact.

Considering the higher prevalence of asymptomatic parasitaemia than symptomatic parasitaemia, periodic testing and treatment should be done for HIV-positive children at their clinics. This may help reduce transmission of malaria by eliminating the reservoir of parasites that this population presents.

Further studies should be undertaken both in vivo and in-vitro, on the anti-retroviral drugs and their anti-malarial potential in Sub Saharan Africa. Studies found were mainly in Western countries where malaria and infectious diseases are not as much of a problem so they do not have the prolonged exposure to a joint therapy of ART and Septrin like is done in Africa. This may therefore mask the effects of drug-drug interaction with respect to Septrin and ART.

CHAPTER SEVEN

7.0 REFERENCES

Alemu, A., Shiferaw, Y., Addis, Z., Mathewos, B., & Birhan, W. (2013). Effect of malaria on HIV/AIDS transmission and progression. *Parasites & Vectors 2013 6:1*, *6*(1), 18. https://doi.org/10.1186/1756-3305-6-18

Amugsi, D. A., Mittelmark, M. B., Lartey, A., Matanda, D. J., & Urke, H. B. (2014). Influence of childcare practices on nutritional status of Ghanaian children: a regression analysis of the Ghana Demographic and Health Surveys. *BMJ Open*, *4*(e0005340). https://doi.org/10.1136/bmjopen-2014

Arimond, M., & Ruel, M. T. (2004). Dietary Diversity Is Associated with Child Nutritional Status: Evidence from 11 Demographic and Health Surveys. *The Journal of Nutrition*, *134*(10), 2579–2585. https://doi.org/10.1093/jn/134.10.2579

Arinaitwe, E., Gasasira, A., Verret, W., Homsy, J., Wanzira, H., Kakuru, A., … Dorsey, G. (2012). The association between malnutrition and the incidence of malaria among young HIV-infected and -uninfected Ugandan children: A prospective study. *Malaria Journal*, *11*. https://doi.org/10.1186/1475-2875-11-90

Arya, A., & Devi, R. (1991). Influence of maternal literacy on the nutritional status of preschool children. *The Indian Journal of Pediatrics*, *58*(2), 265–268. https://doi.org/10.1007/BF02751135

Awine, T., Malm, K., Bart-Plange, C., Silal, S. P., & Byass, P. (2017). Towards malaria control and elimination in Ghana: challenges and decision making tools to guide planning. *GLOBAL HEALTH ACTION, VOL. 10*(1381471). https://doi.org/10.1080/16549716.2017.1381471

Ayisi, J. G., Eijk, A. M. Van, Feiko, O., Kolczak, M. S., Otieno, J. A., Misore, A. O., … Nahlen, B. L. (2003). The effect of dual infection with HIV and malaria on pregnancy outcome in western Kenya, (June 2001). https://doi.org/10.1097/01.aids.0000042977.95433.37

Becquet, R., Bequet, L., Ekouevi, D. K., Viho, I., Sakarovitch, C., Fassinou, P., … Group, A. 1201/1202 D. P. S. (2007). Two-Year Morbidity–Mortality and Alternatives to Prolonged Breast-Feeding among Children Born to HIV-Infected Mothers in Côte d'Ivoire. *PLoS Medicine*, *4*(1), e17. https://doi.org/10.1371/journal.pmed.0040017

Bernard, J., Mtove, G., Mandike, R., Mtei, F., Maxwell, C., & Reyburn, H. (2009). Equity and coverage of insecticide-treated bed nets in an area of intense transmission of Plasmodium falciparum in Tanzania. *Malaria Journal*, *8*(1), 65. https://doi.org/10.1186/1475-2875-8-65

Bhakta, R., & Ganesh-Kumar, A. (2014). *Linkages between Parental Education, Utilization of Health Care Facilities and Health Status of Children: Evidence from India* (No. WP-2014-036). Mumbai, India. Retrieved from http://www.igidr.ac.in/pdf/publication/WP-2014-036.pdf

Bhutta, Z. A., Sommerfeld, J., Lassi, Z. S., Salam, R. A., & Das, J. K. (2014). Global burden, distribution, and interventions for infectious diseases of poverty. *Infectious Diseases of Poverty*, *3*(1), 21. https://doi.org/10.1186/2049-9957-3-21

Birger, R. B., Kouyos, R. D., Cohen, T., Griffiths, E. C., Huijben, S., Mina, M. J., … Metcalf, C. J. E. (2015). The potential impact of coinfection on antimicrobial chemotherapy and drug resistance. *Trends in Microbiology*, *23*(9), 537–544. https://doi.org/10.1016/j.tim.2015.05.002

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., … Maternal and Child Undernutrition Study Group. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet (London, England)*, *371*(9608), 243–260. https://doi.org/10.1016/S0140-6736(07)61690-0

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., … Maternal and Child Nutrition Study Group. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet (London, England)*, *382*(9890), 427–451. https://doi.org/10.1016/S0140-6736(13)60937-X

Boyce, M. R., Menya, D., Turner, E. L., Laktabai, J., & Prudhomme-O'Meara, W. (2018). Evaluation of malaria rapid diagnostic test (RDT) use by community health workers: a longitudinal study in western Kenya. *Malaria Journal*, *17*(1), 206. https://doi.org/10.1186/s12936-018-2358-6

Brahmbhatt, H., Sullivan, D., Kigozi, G., Askin, F., Wabwire-Mangenm, F., Serwadda, D., … Gray, R. (2008). Association of HIV and Malaria With Mother-to-Child. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, *47*(4), 472–476.

Carey, M. P., Morrison-Beedy, D., & Johnson, B. T. (1997). *The HIV-Knowledge Questionnaire: Development and Evaluation of a Reliable, Valid, and Practical Self-Administered Questionnaire*. *AIDS and Behavior* (Vol. 1). Retrieved from https://link.springer.com/content/pdf/10.1023%2FA%3A1026218005943.pdf

Case, A., Lubotsky, D., & Paxson, C. (2002). Economic Status and Health in Childhood: The Origins of the Gradient. *The American Economic Review*, *92*(5), 1308–1334. Retrieved from https://www.princeton.edu/~accase/downloads/Economic_Status_and_Health_in_Childhood.pdf

Case, A., & Paxson, C. (2002). Parental Behavior And Child Health. *Health Affairs*, *21*(2), 164–178. Retrieved from https://www.princeton.edu/~accase/downloads/Parental_Behavior_and_Child_HealthA.pdf

Cheng, W., Wu, Y., Wen, Y., Ma, Y., Zhao, D., Dou, Z., … Zhang, F. (2015). Cotrimoxazole prophylaxis and antiretroviral therapy: an observational cohort study in China. *Bulletin of the World Health Organization*, *93*(3), 152–160. https://doi.org/10.2471/BLT.14.142745

Chuma, J., Gilson, L., & Molyneux, C. (2007). Treatment-seeking behaviour, cost burdens and coping strategies among rural and urban households in Coastal Kenya: an equity analysis. *Tropical Medicine & International Health : TM & IH*, *12*(5), 673–686. https://doi.org/10.1111/j.1365-3156.2007.01825.x

Cowman, A. F., Healer, J., Marapana, D., & Marsh, K. (2016). Malaria: Biology and Disease. *Cell*, *167*(3), 610–624. https://doi.org/10.1016/j.cell.2016.07.055

de Onis, M., Blossner, M., Borghi, E., Frongillo, E. A., & Morris, R. (2004). Underweight in

1990 and 2015. *Jama*, *291*(21), 2600–2606. https://doi.org/10.1016/j.cag.2004.03.007

de Onis, Mercedes, Borghi, E., Arimond, M., Webb, P., Croft, T., Saha, K., … Flores-Ayala, R. (2018). Prevalence thresholds for wasting, overweight and stunting in children under 5 years. *Public Health Nutrition*, *22*(1), 175–179. https://doi.org/10.1017/S1368980018002434

Deen, J. L., Walraven, G. E. L., & von Seidlein, L. (2002). Increased risk for malaria in chronically malnuurished children under 5 years of age in rural gambia. *Journal of Tropical Pediatrics*, *48*(2), 78–83. https://doi.org/10.1093/tropej/48.2.78

Deribew, A., Alemseged, F., Tessema, F., Sena, L., Birhanu, Z., Zeynudin, A., … Biadgilign, S. (2010). Malaria and under-nutrition: A community based study among under-five children at risk of malaria, South-West Ethiopia. *PLoS ONE*, *5*(5). https://doi.org/10.1371/journal.pone.0010775

Diiro, G. M., Affognon, H. D., Muriithi, B. W., Wanja, S. K., Mbogo, C., & Mutero, C. (2016). The role of gender on malaria preventive behaviour among rural households in Kenya. *Malaria Journal*, *15*(1), 14. https://doi.org/10.1186/s12936-015-1039-y

Doherty, T., Chopra, M., Nkonki, L., Jackson, D., & Greiner, T. (2006). Effect of the HIV epidemic on infant feeding in South Africa:" When they see me coming with the tins they laugh at me" *SciELO Public Health*. Retrieved from https://www.scielosp.org/article/bwho/2006.v84n2/90-96/en/

Doherty, T, Chopra, M., Jackson, D., Goga, A., & Colvin, M. (2007). Effectiveness of the WHO/UNICEF guidelines on infant feeding for HIV-positive women: results from a prospective cohort study in South Africa. *Journals.Lww.Com*. Retrieved from https://journals.lww.com/aidsonline/fulltext/2007/08200/effectiveness_of_the_who_unicef_guidelines_on.15.aspx

Doherty, Tanya, Chopra, M., Nkonki, L., Jackson, D., & Greiner, T. (2006). Effect of the HIV epidemic on infant feeding in South Africa: "When they see me coming with the tins they laugh at me" *Bulletin of the World Health Organization*, *019448*(04), 90–96. https://doi.org//S0042-96862006000200008

Doolan, D. L., Dobano, C., & Baird, J. K. (2009). Acquired Immunity to Malaria. *Clinical Microbiology Reviews*, *22*(1), 13–36. https://doi.org/10.1128/CMR.00025-08

Egbewale, B. E., Akindele, A. A., Adedokun, S. A., & Oyekale, O. A. (2018). Prevalence of asymptomatic malaria and anaemia among elderly population in Osun state Southwestern, Nigeria. *International Journal of Community Medicine and Public Health Egbewale BE et Al. Int J Community Med Public Health*, *5*(7), 2650–2656. https://doi.org/10.18203/2394-6040.ijcmph20182449

Ehrhardt, S., Burchard, G. D., Mantel, C., Cramer, J. P., Kaiser, S., Kubo, M., … Mockenhaupt, F. P. (2006). Malaria, Anemia, and Malnutrition in African Children—Defining Intervention Priorities. *The Journal of Infectious Diseases*, *194*(1), 108–114. https://doi.org/10.1086/504688

Eijk, A. M. Van, Ayisi, J. G., Kuile, F. O. Ter, Slutsker, L., Shi, Y. P., Udhayakumar, V., … Nahlen, B. L. (2007). MAJOR ARTICLE HIV , Malaria , and Infant Anemia as Risk Factors for Postneonatal Infant Mortality among HIV-Seropositive Women in Kisumu , Kenya, *196*. https://doi.org/10.1086/518441

Eisele, T. P., Larsen, D. A., Anglewicz, P. A., Keating, J., Yukich, J., Bennett, A., … Steketee, R. W. (2012). Malaria prevention in pregnancy, birthweight, and neonatal mortality: a meta-analysis of 32 national cross-sectional datasets in Africa. *The Lancet. Infectious Diseases*, *12*(12), 942–949. https://doi.org/10.1016/S1473-3099(12)70222-0

Ewing, A. C., King, C. C., Wiener, J. B., Chasela, C. S., Hudgens, M. G., Kamwendo, D., … Kourtis, A. P. (2017). Effects of concurrent exposure to antiretrovirals and cotrimoxazole prophylaxis among HIV-exposed, uninfected infants. *AIDS*, *31*(18), 2455–2463. https://doi.org/10.1097/QAD.0000000000001641

Frempong, R. B., & Annim, S. K. (2017). Dietary diversity and child malnutrition in Ghana. *Heliyon*, *3*(5). https://doi.org/10.1016/J.HELIYON.2017.E00298

Frischknecht, F., & Fackler, O. T. (2016). Experimental systems for studying Plasmodium/HIV coinfection. *FEBS Letters*, *590*(13), 2000–2013. https://doi.org/10.1002/1873-3468.12151

Ghana AIDS Commission. (2017). Ghana AIDS Commision National and Sub-National HIV and AIDS Estimates and Projections Report, 10–11. Retrieved from http://www.ghanaids.gov.gh/gac1/pubs/2017-2022_national_and_sub national_Estimates_Report.pdf

GHANA AIDS COMMISSION. (2013). NATIONAL HIV and AIDS, STI POLICY, February 2013. *NACP Report, 2014*, (February). Retrieved from http://www.ghanaids.gov.gh/gac1/pubs/Ghana National HIV and AIDS STI Policy.pdf

Ghana Statistical Service, National Malaria Control Programme, & National Public Health Reference Laboratory. (2017). *GHANA Malaria Indicator Survey 2016*. Accra. Retrieved from www.DHSprogram.com.

Glover-Amengor, M., Agbemafle, I., Hagan, L. L., Mboom, F. P., Gamor, G., Larbi, A., & Hoeschle-Zeledon, I. (2016). Nutritional status of children 0–59 months in selected intervention communities in northern Ghana from the africa RISING project in 2012. *Archives of Public Health*, *74*(12), 1–12. https://doi.org/10.1186/s13690-016-0124-1

Grobler, L., Siegfried, N., Visser, M. E., Mahlungulu, S. S., & Volmink, J. (2013). Nutritional interventions for reducing morbidity and mortality in people with HIV. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD004536.pub3

Grosse, R. N., & Auffrey, C. (1989). *LITERACY AND HEALTH STATUS IN DEVELOPING COUNTRIES. Annu. Rev. Public Health* (Vol. 10). Retrieved from www.annualreviews.org

GSS. (2017). GHANA Malaria Indicator Survey 2016 Ghana Statistical Service Accra, Ghana National Malaria Control Programme, 25–31. Retrieved from http://www.statsghana.gov.gh/docfiles/publications/MIS26.pdf

Heck, K. E., & Parker, J. D. (2002). Family Structure, Socioeconomic Status, and Access to Health Care for Children. *Health Services Research*, *37*(1). https://doi.org/10.0000/146392499300712

Heller, L. S., & Shattuck, D. (1997). Nutrition Support for Children with HIV/AIDS. *Journal of the American Dietetic Association*, *97*(5), 473–474. https://doi.org/10.1016/S0002-8223(97)00124-7

Hochman, S., & Kim, K. (2009). The Impact ofHIV andMalaria Coinfection: What Is Known and Suggested Venues for Further Study. *Interdisciplinary Perspectives on Infectious Diseases*, *2009*, 617954. https://doi.org/10.1155/2009/617954

Holmes, C. B., Losina, E., Walensky, R. P., Yazdanpanah, Y., & Freedberg, K. A. (2003). *Review of Human Immunodeficiency Virus Type 1-Related Opportunistic Infections in Sub-Saharan Africa*. *Clinical Infectious Diseases* (Vol. 36). Retrieved from https://academic.oup.com/cid/article-abstract/36/5/652/455509

Horta, B. L., & Victora, C. G. (2013a). *Long-term effects of breastfeeding ... A SYSTEMATIC REVIEW ...*. Retrieved from www.who.int

Horta, B. L., & Victora, C. G. (2013b). *Short-term effects of breastfeeding ... A SYSTEMATIC REVIEW ON THE BENEFITS OF BREASTFEEDING ON DIARRHOEA AND PNEUMONIA MORTALITY ...*. Retrieved from www.who.int

Hotez, P. J., & Kamath, A. (2009). Neglected Tropical Diseases in Sub-Saharan Africa : Review of Their Prevalence , Distribution , and Disease Burden. *PLoS Neglected Tropical Diseases*, *3*(8), e412. https://doi.org/10.1371/journal.pntd.0000412

Hotez, P. J., & Molyneux, D. H. (2008). Tropical Anemia: One of Africa's Great Killers and a Rationale for Linking Malaria and Neglected Tropical Disease Control to Achieve a Common Goal. *PLoS Neglected Tropical Diseases*, *2*(7), e270. https://doi.org/10.1371/journal.pntd.0000270

Jegede, F. E., Oyeyi, I., Abdulrahman, S. A., Mbah, H. A., Badru, T., Agbakwuru, C., & Adedokun, O. (2017a). Effect of HIV and malaria parasites co-infection on immune-hematological profiles among patients attending anti-retroviral treatment (ART) clinic in Infectious Disease Hospital Kano, Nigeria. https://doi.org/10.1371/journal.pone.0174233

Jegede, F. E., Oyeyi, T. I., Abdulrahman, S. A., Mbah, H. A., Badru, T., Agbakwuru, C., & Adedokun, O. (2017b). Effect of HIV and malaria parasites co- infection on immune-hematological profiles among patients attending anti-retroviral treatment (ART) clinic in Infectious Disease Hospital Kano , Nigeria. *PLoS ONE*, 1–17.

Kalichman, S. C., & Rompa, D. (2000). Functional health literacy is associated with health status and health-related knowledge in people living with HIV-AIDS. *Journal of Acquired Immune Deficiency Syndromes (1999)*, *25*(4), 337–344. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11114834

Kallem, S., Renner, L., Ghebremichael, M., & Paintsil, E. (2011). Prevalence and Pattern of Disclosure of HIV Status in HIV-Infected Children in Ghana. *AIDS and Behavior*, *15*(6), 1121–1127. https://doi.org/10.1007/s10461-010-9741-9

Kassam, R., Collins, J., & Sekiwunga, R. (2016). Assets and challenges facing caregivers when managing malaria in young children in rural Uganda. *Malaria Journal*, *15*(1). https://doi.org/10.1186/s12936-016-1521-1

Kassam, R., Sekiwunga, R., Collins, J. B., Tembe, J., & Liow, E. (2016). Caregivers' treatment-seeking behaviors and predictors of whether a child received an appropriate antimalarial treatment: A household survey in rural Uganda. *BMC Infectious Diseases*, *16*(1). https://doi.org/10.1186/s12879-016-1815-5

Kassam, R., Sekiwunga, R., MacLeod, D., Tembe, J., & Liow, E. (2016). Patterns of

treatment-seeking behaviors among caregivers of febrile young children: A Ugandan multiple case study Global health. *BMC Public Health*, *16*(1). https://doi.org/10.1186/s12889-016-2813-7

Kidman, R., & Thurman, T. R. (2014). Caregiver burden among adults caring for orphaned children in rural South Africa. *Vulnerable Children and Youth Studies*, *9*(3), 234–246. https://doi.org/10.1080/17450128.2013.871379

Kimani-Murage, E. W., Norris, S. A., Pettifor, J. M., Tollman, S. M., Klipstein-Grobusch, K., Gómez-Olivé, X. F., … Kahn, K. (2011). Nutritional status and HIV in rural South African children. *BMC Pediatrics*, *11*(1), 23. https://doi.org/10.1186/1471-2431-11-23

Kuile, F. O. T. E. R., Parise, M. E., Verhoeff, F. H., & Udhayakumar, V. (2004). THE BURDEN OF CO-INFECTION WITH HUMAN IMMUNODEFICIENCY VIRUS TYPE 1 AND MALARIA IN PREGNANT WOMEN IN SUB-SAHARAN AFRICA, *71*(Suppl 2), 41–54.

Kwabla, M. P., Gyan, C., & Zotor, F. (2018). Nutritional status of in-school children and its associated factors in Denkyembour District, eastern region, Ghana: comparing schools with feeding and non-school feeding policies. *Nutrition Journal*, *17*(1), 8. https://doi.org/10.1186/s12937-018-0321-6

Kwenti, T. E. (2018). Malaria and HIV coinfection in sub-Saharan Africa: prevalence, impact, and treatment strategies. *Research and Reports in Tropical Medicine, Volume 9*, 123–136. https://doi.org/10.2147/RRTM.S154501

Leshabari, S., Blystad, A., & Moland, K. (2012). Difficult choices: infant feeding experiences of HIV-positive mothers in northern Tanzania. *Ajol.Info*. Retrieved from https://www.ajol.info/index.php/saharaj/article/view/30122

Lodha, R., & Kabra, S. K. (2015). Health and nutritional status of HIV infected children. *The Indian Journal of Medical Research*, *141*(1), 10–12. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/25857491

Longdoh Njunda, A., Njumkeng, C., Dickson Nsagha, S., Clement, J., Assob, N., & Kwenti, T. E. (2016). The prevalence of malaria in people living with HIV in Yaounde, Cameroon. https://doi.org/10.1186/s12889-016-3647-z

Mangrio, E., Hansen, K., Lindström, M., Köhler, M., & Rosvall, M. (2011). Maternal educational level, parental preventive behavior, risk behavior, social support and medical care consumption in 8-month-old children in Malmö, Sweden. *BMC Public Health*, *11*(891), 1–9. https://doi.org/10.1186/1471-2458-11-891

Manyanga, V. P., Minzi, O., & Ngasala, B. (2014). Prevalence of malaria and anaemia among HIV infected pregnant women receiving co-trimoxazole prophylaxis in Tanzania: A cross sectional study in Kinondoni Municipality. *BMC Pharmacology and Toxicology*, *15*(1), 1–9. https://doi.org/10.1186/2050-6511-15-24

Martín-Cañavate, R., Sonego, M., Sagrado, M. J., Escobar, G., Rivas, E., Ayala, S., … Commission, E. (2018). Dietary patterns and nutritional status of HIV-infected children and adolescents in El Salvador: A cross-sectional study. *PLOS One*, *13*(5), e0196380. https://doi.org/10.1371/journal.pone.0196380

Martin, S., Elliott-DeSorbo, D. K., Wolters, P. L., Toledo-Tamula, M. A., Roby, G., Zeichner, S., & Wood, L. V. (2007). Patient, caregiver and regimen characteristics

associated with adherence to highly active antiretroviral therapy among HIV-infected children and adolescents. *The Pediatric Infectious Disease Journal*, *26*(1), 61–67. https://doi.org/10.1097/01.inf.0000250625.80340.48

Maziarz, M., Nabalende, H., Otim, I., Legason, I. D., Kinyera, T., Ogwang, M. D., … Mbulaiteye, S. M. (2018). A cross-sectional study of asymptomatic Plasmodium falciparum infection burden and risk factors in general population children in 12 villages in northern Uganda. *Malaria Journal*, *17*(1), 240. https://doi.org/10.1186/s12936-018-2379-1

Mbale, E. W., Moxon, C. A., Mukaka, M., Chagomerana, M., Glover, S., Chisala, N., … Mallewa, M. (2016). HIV coinfection influences the inflammatory response but not the outcome of cerebral malaria in Malawian children. *Journal of Infection*, *73*(3), 189–199. https://doi.org/10.1016/j.jinf.2016.05.012

MEASURE Evaluation. (2017). The importance of gender in malaria data, (March), 2012–2015. Retrieved from https://www.measureevaluation.org/resources/publications/fs-17-205d

Megnekou, R., Djontu, J. C., Nana, B. C., Bigoga, J. D., Fotso, M., Fogang, B., & Leke, R. F. G. (2018). Accuracy of One Step malaria rapid diagnostic test (RDT) in detecting Plasmodium falciparum placental malaria infection in women living in Yaoundé, Cameroon. *Malaria Journal*, *17*(1), 450. https://doi.org/10.1186/s12936-018-2595-8

Ministry Of Health. (2016). *Antiretroviral therapy in Ghana*. Retrieved from https://aidsfree.usaid.gov/sites/default/files/gh_guidelines_arv_therapy.pdf

Ministry Of Health, G. (2007). *Under Five's Child Health Policy: 2007-2015*. Retrieved from https://extranet.who.int/nutrition/gina/sites/default/files/GHA 2007 Under Five%27s Child Health Policy 2007 - 2015.pdf

Mitiku, I., & Assefa, A. (2017). Caregivers' perception of malaria and treatment-seeking behaviour for under five children in Mandura District, West Ethiopia: A cross-sectional study. *Malaria Journal*, *16*(1). https://doi.org/10.1186/s12936-017-1798-8

Moolasart, V., Chottanapund, S., Ausavapipit, J., & Ampornareekul, S. (2017). Prevalence and Risk Factors of Malnutrition among HIV-Infected Children Aged 2-18 Years: A Cross-Sectional Study. https://doi.org/10.21767/2573-0282.100036

Müller, O., Garenne, M., Kouyaté, B., & Becher, H. (2003). The association between protein-energy malnutrition, malaria morbidity and all-cause mortality in West African children. *Tropical Medicine and International Health*, *8*(6), 507–511. https://doi.org/10.1046/j.1365-3156.2003.01043.x

Mwanje, L. F. (2013). KNOWLEDGE , ATTITUDES AND PRACTICES ON MALARIA PREVENTION AND CONTROL IN UGANDA KNOWLEDGE , ATTITUDES AND PRACTICES ON MALARIA PREVENTION AND CONTROL IN UGANDA, (January).

Naing, C., Sandhu, N. K., & Wai, V. N. (2016a). The Effect of Malaria and HIV Co-Infection on Anemia. *Medicine (United States)*, *95*(14). https://doi.org/10.1097/MD.0000000000003205

Naing, C., Sandhu, N. K., & Wai, V. N. (2016b). The Effect of Malaria and HIV Co-Infection on Anemia, *95*(14), 1–10. https://doi.org/10.1097/MD.0000000000003205

National Malaria Control Program, University of Health & Allied Sciences, AngloGold Ashanti Malaria Control Program, World Health Organization, & The INFORM Project. (2013). *An epidemiological profile of malaria and its control in Ghana*. Retrieved from https://www.linkmalaria.org/sites/link/files/content/country/profiles/Ghana-epi-report-2014.pdf

National Malaria Control Programme. (2015). Microscopy - National Malaria Control Programme. Retrieved July 24, 2019, from http://www.ghanahealthservice.org/malaria/item.php?nmcpiid=69&nmcpscid=127&nmcpcid=90

Ndirango, M., Wariero, J. O., Sachs, S. E., Masibo, P., & Deckelbaum, R. J. (2011). Nutritional status of under-five children in HIV-affected households in western Kenya. *Food and Nutrition Bulletin*, *32*(2), 159–167. Retrieved from https://journals.sagepub.com/doi/pdf/10.1177/156482651103200208

Ng'ang'a, P. N., Jayasinghe, G., Kimani, V., Shililu, J., Kabutha, C., Kabuage, L., … Mutero, C. (2009). Bed net use and associated factors in a rice farming community in Central Kenya. *Malaria Journal*, *8*(1), 64. https://doi.org/10.1186/1475-2875-8-64

Ngasala, B. E., Malmberg, M., Carlsson, A. M., Ferreira, P. E., Petzold, M. G., Blessborn, D., … Mårtensson, A. (2011). Effectiveness of artemether-lumefantrine provided by community health workers in under-five children with uncomplicated malaria in rural Tanzania: an open label prospective study. *Malaria Journal*, *10*(1), 64. https://doi.org/10.1186/1475-2875-10-64

Njunda, A. L., Njumkeng, C., Nsagha, S. D., Assob, J. C. N., & Kwenti, T. E. (2016). The prevalence of malaria in people living with HIV in Yaounde, Cameroon. *BMC Public Health*, *16*(1), 1–7. https://doi.org/10.1186/s12889-016-3647-z

Nkumama, I. N., O'Meara, W. P., Osier, F. H. A., O'Meara, W. P., & Osier, F. H. A. (2017). Changes in Malaria Epidemiology in Africa and New Challenges for Elimination. *Trends in Parasitology*, *33*(2), 128–140. https://doi.org/10.1016/j.pt.2016.11.006

Ofunne, I. (2014). ASSESSMENT OF THE AND PRACTICES OF CAREGIVERS OF HIV POSITIVE CHILDREN ON TREATMENT IN PRETORIA , SOUTH AFRICA : A CASE STUDY OF, (April).

Omoti, C. E., Ojide, C. K., Lofor, P. V., Eze, E., Eze, J. C., & Omoti, C. E. (2013). Prevalence of parasitemia and associated immunodeficiency among HIV-malaria co-infected adult patients with highly active antiretroviral therapy. *Asian Pacific Journal of Tropical Medicine*, *6*(2), 126–130. https://doi.org/10.1016/S1995-7645(13)60007-3

Onankpa, B. O., Jiya, N. M., & Yusuf, T. (2017a). Malaria parasitemia in HIV-infected children attending antiretroviral therapy clinic in a teaching hospital. *Sahel Medical Journal*, *20*(1), 30–32. https://doi.org/10.4103/1118-8561.204329

Onankpa, Jiya, N. M., & Yusuf, T. (2017b). Malaria parasitemia in HIV-infected children attending antiretroviral therapy clinic in a teaching hospital. *Sahel Medical Journal*, *20*(1), 30. https://doi.org/10.4103/1118-8561.204329

Onyango, A. W. (2003). Dietary diversity, child nutrition and health in contemporary African communities. *Comparative Biochemistry and Physiology - A Molecular and Integrative Physiology*. Elsevier Inc. https://doi.org/10.1016/S1095-6433(03)00071-0

Onyenekwe, C., Ilika, A. L., & Ezeani, M. (2014). Prevalence of malaria as co-infection in HIV-infected individuals in a malaria endemic area of southeastern Nigeria, (December 2007).

Orish, V. N., De-Gaulle, V. F., & Sanyaolu, A. O. (2018). Interpreting rapid diagnostic test (RDT) for Plasmodium falciparum. *BMC Research Notes*, *11*(1), 850. https://doi.org/10.1186/s13104-018-3967-4

Ouedraogo SM, Sangaré I, Sourabié Y, Zongo R, Zida A, Ouedraogo AS, Fofana S, G. R. and N. B. (2015). HIV and Malaria Co infection in the Department of Paediatrics of the University Teaching Hospital Souro Sanou. *Emergency Medicine: Open Access 2015 5:4*, *5*(4), 1–6. https://doi.org/10.4172/2165-7548.1000260

Penazzato, M., Irvine, C., Vicari, M., Essajee, M., Sharma, A., Puthanakit, T., … Doherty, M. (2018). S UPPLEMENT A RTICLE A Global Research Agenda for Pediatric HIV, *78*, 10–15.

Penda, C. I., Eboumbou Moukoko, E. C., Nolla, N. P., Evindi Abomo, O. N., & Koki Ndombo, P. (2018). Malnutrition among HIV infected children under 5 years of age at the Laquintinie hospital Douala, Cameroon. *Pan African Medical Journal*, *30*. https://doi.org/10.11604/pamj.2018.30.91.15832

Pérez-Escamilla, R., Dessalines, M., Finnigan, M., Pachón, H., Hromi-Fiedler, A., & Gupta, N. (2009). Household Food Insecurity Is Associated with Childhood Malaria in Rural Haiti. *The Journal of Nutrition*, *139*(11), 2132–2138. https://doi.org/10.3945/jn.109.108852

Poda, G. G., Hsu, C.-Y., & Chao, J. C.-J. (2017). Malnutrition is associated with HIV infection in children less than 5 years in Bobo-Dioulasso City, Burkina Faso A case-control study. *Medicine*, *96*(21). https://doi.org/10.1097/MD.0000000000007019

PrayGod, G., Friis, H., & Filteau, S. (2018). Nutritional support to reduce mortality in patients with HIV? *The Lancet. HIV*, *5*(5), e202–e204. https://doi.org/10.1016/S2352-3018(18)30047-X

PRESIDENT'S MALARIA INITIATIVE, GHANA HEALTH SERVICE, USAID, & CDC. (2013). *GHANA URBAN MALARIA STTUDY*. Retrieved from https://www.jsi.com/Independent/Docs/GhanaUrbanMalariaStudy.pdf

Rollins, N. C. N., Becquet, R., … R. B., Bland, R. M., Coutsoudis, A., Coovadia, H. M., & Newell, M. L. (2008). Infant feeding, HIV transmission and mortality at 18 months: the need for appropriate choices by mothers and prioritization within programmes. *Ncbi.Nlm.Nih.Gov*. https://doi.org/10.1097/QAD.0b013e328312c740

Rollins, N. C., Ndirangu, J., Bland, R. M., Coutsoudis, A., Coovadia, H. M., & Newell, M.-L. (2013). Exclusive Breastfeeding, Diarrhoeal Morbidity and All-Cause Mortality in Infants of HIV-Infected and HIV Uninfected Mothers: An Intervention Cohort Study in KwaZulu Natal, South Africa. *PLoS ONE*, *8*(12), e81307. https://doi.org/10.1371/journal.pone.0081307

Saaka, M., & Galaa, S. Z. (2017). How is dietary diversity related to haematological status of preschool children in Ghana? *Food & Nutrition Research*, *61*(1), 1333389. https://doi.org/10.1080/16546628.2017.1333389

Sanders, L. M., Thompson, V. T., & Wilkinson, J. D. (2007). Caregiver Health Literacy and

the Use of Child Health Services. *Pediatrics*, *119*(1), e86–e92. https://doi.org/10.1542/peds.2005-1738

Sangarei, Y. S., SM, O., R, Z., A, Z., AS, O., ... B, N. (2015). Coinfection HIV and Malaria in Department of Paediatrics of the University Hospital Souro Sanou. *Journal of Hematology & Thromboembolic Diseases 2015 3:4*, *3*(4), 1–6. https://doi.org/10.4172/2329-8790.1000213

Sanyaolu, A. O., Fagbenro-Beyioku, A. F., Oyibo, W. A., Badaru, O. S., Onyeabor, O. S., & Nnaemeka, C. I. (2013). Malaria and HIV co-infection and their effect on haemoglobin levels from three health-care institutions in Lagos, southwest Nigeria. *African Health Sciences*, *13*(2), 295–300. https://doi.org/10.4314/ahs.v13i2.14

Simon-Oke, I. A. (2017). Prevalence of Malaria Parasite among Asymptomatic and Symptomatic Students of Federal University of Technology, Akure, Ondo State. *British Journal of Research*, *4*(1). https://doi.org/10.21767/2394-3718.100005

Skinner-Adams, T. S., McCarthy, J. S., Gardiner, D. L., & Andrews, K. T. (2008). HIV and malaria co-infection: interactions and consequences of chemotherapy. *Trends in Parasitology*, *24*(6), 264–271. https://doi.org/10.1016/j.pt.2008.03.008

Slutsker, L., & Marston, B. J. (2007). HIV and malaria: interactions and implications. *Current Opinion in Infectious Diseases*, *20*(1), 3–10. https://doi.org/10.1097/QCO.0b013e328012c5cd

Sodjah, D., & Bayali, A. (2019). Ghana Starts Malaria Vaccine Implementation - Government of Ghana. Retrieved July 30, 2019, from http://www.ghana.gov.gh/index.php/media-center/news/5513-ghana-starts-malaria-vaccine-implementation

StataCorp. (2017). Stata Statistical Software: Release 15. *Stata Statistical Software*. College Station, TX: StataCorp LLC. Retrieved from https://www.stata.com/support/faqs/resources/citing-software-documentation-faqs/

Statistical Service Accra, G. (2015). *Ghana Demographic and Health Survey 2014*. Retrieved from www.DHSprogram.com.

Sumari, D., Mwingira, F., Selemani, M., Mugasa, J., Mugittu, K., & Gwakisa, P. (2017). Malaria prevalence in asymptomatic and symptomatic children in Kiwangwa, Bagamoyo district, Tanzania. *Malaria Journal*, *16*(1), 222. https://doi.org/10.1186/s12936-017-1870-4

Sunguya, B. F., Poudel, K. C., Mlunde, L. B., Urassa, D. P., Yasuoka, J., & Jimba, M. (2014). Poor Nutrition Status and Associated Feeding Practices among HIV-Positive Children in a Food Secure Region in Tanzania: A Call for Tailored Nutrition Training. *PLoS ONE*, *9*(5), e98308. https://doi.org/10.1371/journal.pone.0098308

Sunguya, B. F., Poudel, K. C., Otsuka, K., Yasuoka, J., Mlunde, L. B., Urassa, D. P., ... Jimba, M. (2011). Undernutrition among HIV-positive children in Dar es Salaam, Tanzania: antiretroviral therapy alone is not enough. *BMC Public Health*, *11*(1), 869. https://doi.org/10.1186/1471-2458-11-869

Suryavanshi, N., Jonnalagadda, S., Erande, A. S., Sastry, J., Pisal, H., Bharucha, K. E., ... Shankar, A. V. (2003a). Infant Feeding Practices of HIV-Positive Mothers in India. *The Journal of Nutrition*. https://doi.org/10.1093/jn/133.5.1326

Suryavanshi, N., Jonnalagadda, S., Erande, A. S., Sastry, J., Pisal, H., Bharucha, K. E., … Shankar, A. V. (2003b). Community and International Nutrition Infant Feeding Practices of HIV-Positive Mothers in India 1,2. *J. Nutr*, *133*, 1326–1331. Retrieved from https://academic.oup.com/jn/article-abstract/133/5/1326/4558594

Suthar, A. B., Granich, R., Mermin, J., Annelies, &, & Rie, V. (2012). Systematic reviews Effect of cotrimoxazole on mortality in HIV-infected adults on antiretroviral therapy: a systematic review and meta-analysis. *Bull World Health Organ*, *90*, 128–138. https://doi.org/10.2471/BLT.11.093260

Suthar, A. B., Granich, R., Mermin, J., Annelies, &, Rie, V., & van Rie, A. (2012). Effect of cotrimoxazole on mortality in HIV-infected adults on antiretroviral therapy: A systematic review and meta-analysis. *Bulletin of the World Health Organization*, *90*(2), 128–138. https://doi.org/10.2471/BLT.11.093260

Taha, T. E., Kumwenda, N. I., Hoover, D. R., Kafulafula, G., Fiscus, S. A., Nkhoma, C., … Broadhead, R. L. (2006). The impact of breastfeeding on the health of HIV-positive mothers and their children in sub-Saharan Africa. *Bulletin of the World Health Organization*, *84*, 546–554. https://doi.org/10.1590/S0042-96862006000700016

Tay, S. C. K., Badu, K., Mensah, A. A., & Gbedema, S. Y. (2015). The prevalence of malaria among HIV seropositive individuals and the impact of the co-infection on their hemoglobin levels. *Annals of Clinical Microbiology and Antimicrobials*, *14*(10). https://doi.org/10.1186/s12941-015-0064-6

Ter Kuile, F. O., Parise, M. E., Verhoeff, F. H., Udhayakumar, V., Newman, R. D., Van Eijk, A. M., … Steketee, R. W. (2004). *THE BURDEN OF CO-INFECTION WITH HUMAN IMMUNODEFICIENCY VIRUS TYPE 1 AND MALARIA IN PREGNANT WOMEN IN SUB-SAHARAN AFRICA*. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK3744/pdf/Bookshelf_NBK3744.pdf

Thairu, L. N., Pelto, G. H., Rollins, N. C., Bland, R. M., & Ntshangase, N. (2005). Sociocultural influences on infant feeding decisions among HIV-infected women in rural Kwa-Zulu Natal, South Africa. *Maternal and Child Nutrition*, *1*(1), 2–10. https://doi.org/10.1111/j.1740-8709.2004.00001.x

Thandar, M. M., Kyaw, M. P., Jimba, M., & Yasuoka, J. (2015). Caregivers' treatment-seeking behaviour for children under age five in malaria-endemic areas of rural Myanmar: A cross-sectional study. *Malaria Journal*, *14*(1). https://doi.org/10.1186/1475-2875-14-1

Torheim, L. E., Ouattara, F., Diarra, M. M., Thiam, F. D., Barikmo, I., Hatløy, A., & Oshaug, A. (2004). Nutrient adequacy and dietary diversity in rural Mali: Association and determinants. *European Journal of Clinical Nutrition*, *58*(4), 594–604. https://doi.org/10.1038/sj.ejcn.1601853

Town, A., Eke, R. A., Chigbu, L. N., & Nwachukwu, W. (2006). *High Prevalence of Asymptomatic Plasmodium Infection in a Suburb of*. *Annals of African Medicine* (Vol. 5). Retrieved from http://www.bioline.org.br/pdf?am06010

UNAIDS, & UNIFEM. (2008). *Caregiving in the context of HIV/AIDS*. Retrieved from http://www.un.org/womenwatch/daw

UNICEF. (2013). *Key Messages Booklet The Community Infant and Young Child Feeding*

Counselling Package Key Messages Booklet. Retrieved from https://www.unicef.org/ghana/media/1326/file/UN726549.pdf

UNICEF. (2016). HIV and nutrition. Retrieved August 2, 2019, from https://www.unicef.org/nutrition/index_HIV.html

UNICEF. (2019). Malnutrition in Children - UNICEF DATA. Retrieved August 2, 2019, from https://data.unicef.org/topic/nutrition/malnutrition/

Van Eijk, A. M., Ayisi, J. G., Kuile, F. O. Ter, Slutsker, L., Shi, Y. P., Udhayakumar, V., … Nahlen, B. L. (2007a). HIV, Malaria, and Infant Anemia as Risk Factors for Postneonatal Infant Mortality among HIV-Seropositive Women in Kisumu, Kenya, 196. https://doi.org/10.1086/518441

Van Eijk, A. M., Ayisi, J. G., Kuile, F. O. Ter, Slutsker, L., Shi, Y. P., Udhayakumar, V., … Nahlen, B. L. (2007b). HIV, Malaria, and Infant Anemia as Risk Factors for Postneonatal Infant Mortality among HIV-Seropositive Women in Kisumu, Kenya, 196. https://doi.org/10.1086/518441

Van Eijk, A. M., Ayisi, J. G., Ter Kuile, F. O., Misore, A. O., Otieno, J. A., Kolczak, M. S., … Nahlen, B. L. (2002). *MALARIA AND HUMAN IMMUNODEFICIENCY VIRUS INFECTION AS RISK FACTORS FOR ANEMIA IN INFANTS IN KISUMU, WESTERN KENYA*. Retrieved from http://www.ajtmh.org/docserver/fulltext/14761645/67/1/12363063.pdf?expires=1538749657&id=id&accname=guest&checksum=AC9D5D6AF0E28A2B2DFAC38AC75A2DCB

Van Geertruyden, J.-P. (2014). Interactions between malaria and human immunodeficiency virus anno 2014. *Clinical Microbiology and Infection : The Official Publication of the European Society of Clinical Microbiology and Infectious Diseases*, *20*(4), 278–285. https://doi.org/10.1111/1469-0691.12597

Van Geertruyden, J.-P. P. J.-P. (2014). Interactions between malaria and human immunodeficiency virus anno 2014. *Clinical Microbiology and Infection*, *20*(4), 278–285. https://doi.org/10.1111/1469-0691.12597

Walingo, M., & Ekesa, B. (2013). Nutrient intake, morbidity and nutritional status of preschool children are influenced by agricultural and dietary diversity in Western Kenya. *Pakistan Journal of Nutrition*, *12*(9), 854–859. Retrieved from http://docsdrive.com/pdfs/ansinet/pjn/2013/854-859.pdf

Wambui, W. M., Kimani, S., & Odhiambo, E. (2018). Determinants of Health Seeking Behavior among Caregivers of Infants Admitted with Acute Childhood Illnesses at Kenyatta National Hospital, Nairobi, Kenya. *International Journal of Pediatrics*, *2018*, 1–11. https://doi.org/10.1155/2018/5190287

WHO. (2002). *Infant and young child nutrition Global strategy on infant and young child feeding Report by the Secretariat*. Retrieved from http://apps.who.int/gb/archive/pdf_files/WHA55/ea5515.pdf?ua=1

WHO. (2004). *Malaria and HIV interactions and their implications for public health policy*.

WHO. (2010). WHO Policy recommendation on Intermittent Preventive Treatment during infancy for Plasmodium falciparum malaria control in Africa Contra-indications. *Who*, *2009*(March), 4–6. Retrieved from

http://www.who.int/malaria/news/WHO_policy_recommendation_IPTi_032010.pdf

WHO, R. O. for A. (2017). Ghana announces the roll out of Malaria Vaccine Implementation Programme (MVIP) | WHO | Regional Office for Africa. Retrieved July 30, 2019, from https://www.afro.who.int/news/ghana-announces-roll-out-malaria-vaccine-implementation-programme-mvip

Woldu, D. O., & Haile, Z. T. (2015). Gender Roles and Perceptions of Malaria Risk in Agricultural Communities of Mwea Division in Central Kenya. *Women & Health*, *55*(2), 227–243. https://doi.org/10.1080/03630242.2014.979968

World Health Organisation. (2013). Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: recommendations for a public health approach. *WHO Guidelines*, (June), 272. https://doi.org/978 92 4 150572 7

World Health Organisation. (2018a). HIV/AIDS. Retrieved October 21, 2018, from http://www.who.int/en/news-room/fact-sheets/detail/hiv-aids

World Health Organisation. (2018b). WHO Fact Sheet on Malaria. Retrieved October 21, 2018, from http://www.who.int/en/news-room/fact-sheets/detail/malaria

World Health Organization. (2010). *Interpretation Guide Nutrition Landscape Information System (NLIS) Country Profile indiCators*. Geneva. Retrieved from https://www.who.int/nutrition/nlis_interpretation_guide.pdf

World Health Organization. (2015). *THE GLOBAL PREVALENCE OF ANAEMIA IN 2011*. Retrieved from www.who.int

World Health Organization. (2017). *WORLD MALARIA REPORT 2017*. GENEVA. Retrieved from www.who.int/malaria

World Health Organization. (2018a). Children: reducing mortality. Retrieved November 16, 2018, from http://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality

World Health Organization. (2018b). Infant and young child feeding. Retrieved November 16, 2018, from http://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding

World Health Organization. (2018c). WHO | Application tools. Retrieved July 9, 2019, from https://www.who.int/growthref/tools/en/

World Health Organization, & United Nations Children's Fund. (2004). *ANAEMIA, A PUBLIC HEALTH PROBLEM*. Retrieved from http://www.ajcn.

World Health Organization, & United Nations Children's Fund. (2016). *Guideline: updates on HIV and infant feeding: the duration of breastfeeding, and support from health services to improve feeding practices among mothers living with HIV*. Geneva. Retrieved from http://www.who.int

Yohannes, K., Dulhunty, J. M., Kourleoutov, C., Manuopangai, V. T., Polyn, M. K., Parks, W. J., … Bryan, J. H. (2000). Malaria control in central Malaita, Solomon Islands. 1. The use of insecticide-impregnated bed nets. *Acta Tropica*, *75*(2), 173–183. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/10708657

Yu, J. (2015). Parental Education Matters for Adolescent Health: The Importance of Parental

Education in the US. *Journal of Studies in Social Sciences, 11*(2), 160–195. Retrieved from https://infinitypress.info/index.php/jsss/article/viewFile/1089/497

CHAPTER EIGHT
8.0 APPENDICES

8.1 APPENDIX A (PARENTAL CONSENT FOR ALL CHILDREN)

PARTICIPANT INITIALS..... ID CODE.....

PARENTAL INFORMATION SHEET (To be translated into an appropriate local language where necessary)

Title: FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND GREATER ACCRA REGIONAL HOSPITAL IN ACCRA.

PRINCIPAL INVESTIGATOR: DR. ANITA M. TIBBOH

ADDRESS: SCHOOL OF PUBLIC HEALTH

UNIVERSITY OF GHANA

LEGON

PHONE: +233-30 2665406, +233-50-5319934

EMAIL: momotibboh@st.ug.edu.gh

Introduction

My name is Anita Momo Tibboh, and I am undertaking a Masters of Public Health course at the School of Public Health, University of Ghana. The study titled FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND

GREATER ACCRA REGIONAL HOSPITAL IN ACCRA.is a part of my research to fulfill my academic requirements for the course.

General Information about Research

Malaria is a disease that is very common in our part of the world, and is especially dangerous for children. This is a project to learn about the factors that are associated with malaria in children like your child. So I want to find out how children like your child/ward are able to get malaria, and whether they can have malaria but not show it. I also want to know if when they get malaria, their blood level drops, and whether any of the medicines they are currently taking helps to protect them from malaria.

Nature of research

As part of the study I will be asking you some questions about your household and your child. You may find some of the questions embarrassing. I will also have to take a small amount (two to three drops, 0.5mls) of your child's blood to do some tests. It is not a lot of blood and will not take too much time, but will require a small finger prick which may be a little painful. I will also check your child's height and weight to see if he/she is growing well. If I find something that is not helpful to your child, I will tell your child's doctors so they can treat him/her. I will also look in your child's folder to get some information for the project.

Possible Costs, Risks and Discomforts

I will give your child a small finger prick to take two to three drops (0.5mls) of blood. It may be a little painful, but should cause no harm in any way. You may keep a little longer than your usual clinic visits because of my study but I will try to be as quick as possible. The project will not require any extra input in terms of money from you.

Possible Benefits

The project will help us to know if your child has malaria and if his/her blood level is low so we can treat him/her. The measurements will also help us to know if your child/ward is growing well. All the information collected in the study will contribute to scientific knowledge about children like your child and may be used to help them.

Outcome and Feedback

You will get information about whether your child has malaria or not and whether his/her blood level is low. You will also be told if his/her body measurements are normal or not. All the information from the study will be put together in a report that will be shared with your hospital, and may inform how you are taken care of in the clinic.

Confidentiality

The information you provide to us will not be shared with anyone who is not permitted to have information concerning the study. The information you give to us will be strictly protected from all persons without the required permission to the study. Your name will not be on the papers I write your information on, only a number will be there. This same number will be used to label the tests we do so that your results are not mixed up. Information from the study will be kept for up to 5 years under lock and key and may be destroyed by burning thereafter.

Compensation

There will be no monetary compensation given for this study. Your child will be provided with some snacks (sachets of milo, and nido milk powder) to compensate for the inconvenience of waiting, when you have completed the study.

Voluntary Participation and Right to Leave the Research

Participation in this study is voluntary. You can refuse or withdraw your child/ward from the study with no consequences, even if you initially agreed to take part. Nothing will be done to you or your child/ward, and you can continue with your clinic as usual.

Funding information: The project is being funded by the WORLD HEALTH ORGANIZATION through the TDR program in collaboration with the University of Ghana School of Public Health.

Conflict of Interest: There are no conflicting interests to declare. The information generated from this study is owned by the University of Ghana. Results may be shared with the Ghana Health Service and the World Health Organization.

Provision of Information: You will be given copies of the information provided to take home with you.

Contacts for Additional Information

You can contact the principal investigator, Anita M. Tibboh on this number 0505319934 if you have any questions or problems concerning the study.

Your Child's Rights as a Participant

This research has been reviewed and approved by the GHANA HEALTH SERVICE ETHICAL REVIEW COMMITTEE (GHS-ERC) and the NOGUCHI MEMORIAL INSTITUTE OF MEDICAL RESEARCH INSTITUTIONAL REVIEW BOARD (NMIMR-IRB) If you have any questions about your child's rights as a research participant you can contact the GHS-ERC between the hours of 8am-5pm through the landline 0302 681109. You can also contact the administrator of the GHS-ERC Ms. Hannah Frimpong at email: hannah.frimpong@ghsmail.org or on mobile numbers 0243235225 or 0507041223.

PARENTAL CONSENT FORM

Title: FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND GREATER ACCRA REGIONAL HOSPITAL IN ACCRA.

PARTICIPANTS' STATEMENT

I declare that I have read the above document describing the intent, nature, benefits, risks and procedures for the research titled "FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN HIV-POSITIVE CHILDREN UNDER 5 ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL IN ACCRA", or it has been read and explained to me in a language I understand (□English □ Ga □Akan □Ewe). I have been given an opportunity to have any questions about the research answered to my satisfaction. I understand that it is research, participation is voluntary and any information I give will be confidential. I also understand that I can withdraw my consent for my child/ward to participate at any time. I agree that my child should participate as a volunteer.

Name or Initials of Participant..... ID Code .....

Participants'Signature..... OR ThumbPrint.....Date:.....

INTERPRETERS' STATEMENT

I confirm that I have translated the above document describing the intent, nature, benefits, risks and procedures for the research titled "FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN HIV-POSITIVE CHILDREN UNDER 5 ATTENDING SPECIAL

CLINIC AT THE PRINCESS MARIE LOUISE CHILDREN'S HOSPITAL IN ACCRA" to the participant to the best of my ability in (□ Ga □Akan □Ewe) to his/her understanding, , and that he/she had all questions answered.

Name of Interpreter.....

Signature of Interpreter.....

Date:.....

WITNESS STATEMENT

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures of the above named study were read to the child's parent or guardian in (□ Ga □Akan □Ewe). All questions were answered and the child's parent has voluntarily agreed that his or her child should take part in the research.

Name:.....

Signature.....OR Thumb Print .....

Date:.....

INVESTIGATOR STATEMENT

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual. All questions raised have been addressed.

Researcher's name.....

Signature .....

Date.....

8.2 APPENDIX B (INFORMATION SHEET AND ASSENT FORM FOR CHILDREN MORE THAN 7 YEARS)

PARTICIPANT INITIALS..... ID CODE.....

ADOLESCENT (7 – 12YRS) INFORMATION SHEET (To be translated into an appropriate local language where necessary)

Title: FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND GREATER ACCRA REGIONAL HOSPITAL IN ACCRA.

PRINCIPAL INVESTIGATOR: DR. ANITA M. TIBBOH

ADDRESS: SCHOOL OF PUBLIC HEALTH

UNIVERSITY OF GHANA

LEGON

PHONE: +233-30 2665406, +233-50-5319934

EMAIL: momotibboh@st.ug.edu.gh

Introduction

My name is Anita Momo Tibboh, and I am undertaking a Masters of Public Health course at the School of Public Health, University of Ghana. The study titled FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND GREATER ACCRA REGIONAL HOSPITAL IN ACCRA.is a part of my research to fulfill my academic requirements for the course.

General Information about Research

Malaria is a disease that is very common in our part of the world, and is especially dangerous for children. This is a project to learn about the factors that are associated with malaria in children like you. So I want to find out how children like you get malaria, and whether you can have malaria but not show it. I also want to know if when you get malaria, your blood level drops, and whether any of the medicines you are currently taking helps to protect you from malaria.

Nature of research

As part of the study I will be asking you some questions. You may find some of the questions embarrassing. I will also have to take a small amount (two to three drops, 0.5mls) of your blood to do some tests. It is not a lot of blood and will not take too much time, but will require a small finger prick which may be a little painful. I will also check your height and weight to see if you are growing well. If I find something that is not helpful to you, I will tell your doctors so they can treat you. I will also look in your folder to get some information for the project.

Possible Costs, Risks and Discomforts

I will give you a small finger prick to take two to three drops (0.5mls) of blood. It may be a little painful, but should cause no harm in any way. You may keep a little longer than your usual clinic visits because of my study but I will try to be as quick as possible. The project will not require any extra input in terms of money from you.

Possible Benefits

The project will help us to know if you have malaria and if your blood level is low so we can treat you. The measurements will also help us to know if you are growing well. All the

information collected in the study will contribute to scientific knowledge about children and may be used to help all of you.

Outcome and Feedback

You will get information about whether you have malaria or not and whether your blood level is low. You will also be told if your body measurements are normal or not. All the information from the study will be put together in a report that will be shared with your hospital, and may inform how you are taken care of in the clinic.

Confidentiality

The information you provide to us will not be shared with anyone who is not permitted to have information concerning the study. The information you give to us will be strictly protected from all persons without the required permission to the study. Your name will not be on the papers I write your information on, only a number will be there. This same number will be used to label the tests we do so that your results are not mixed up. Information from the study will be kept for up to 5 years under lock and key and may be destroyed by burning thereafter.

Compensation

There will be no monetary compensation given for this study. You will be provided with some snacks (sachets of milo, and nido milk powder) to compensate for the inconvenience of waiting, when you have completed the study.

Voluntary Participation and Right to Leave the Research

Participation in this study is voluntary. You can refuse or withdraw from the study with no consequences, even if you initially agreed to take part. Nothing will be done to you, and you can continue with your clinic as usual.

Funding information: The project is being funded by the WORLD HEALTH ORGANIZATION through the TDR program in collaboration with the University of Ghana School of Public Health.

Conflict of Interest: There are no conflicting interests to declare. The information generated from this study is owned by the University of Ghana. Results may be shared with the Ghana Health Service and the World Health Organization.

Provision of Information: You will be given copies of the information provided to take home with you.

Contacts for Additional Information

You can contact the principal investigator, Anita M. Tibboh on this number 0505319934 if you have any questions or problems concerning the study.

Your Rights as a Participant

This research has been reviewed and approved by the GHANA HEALTH SERVICE ETHICAL REVIEW COMMITTEE (GHS-ERC) and the NOGUCHI MEMORIAL INSTITUTE OF MEDICAL RESEARCH INSTITUTIONAL REVIEW BOARD (NMIMR-IRB) If you have any questions about your child's rights as a research participant you can contact the GHS-ERC between the hours of 8am-5pm through the landline 0302 681109. You can also contact the administrator of the GHS-ERC Ms. Hannah Frimpong at email: hannah.frimpong@ghsmail.org or on mobile numbers 0243235225 or 0507041223.

ADOLESCENT (7 – 12YRS) ASSENT FORM

Title: FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND GREATER ACCRA REGIONAL HOSPITAL IN ACCRA.

PARTICIPANTS' STATEMENT

I acknowledge that I have read the above document describing the intent, nature, benefits, risks and procedures for the research titled "FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND GREATER ACCRA REGIONAL HOSPITAL IN ACCRA", or it has been read and explained to me in a language I understand (□English □ Ga □Akan □Ewe). I have been given an opportunity to have any questions about the research answered to my satisfaction. I understand that it is research, participation is voluntary and any information I give will be confidential. I also understand that I can withdraw my consent to participate at any time. I voluntarily agree to participate as a volunteer.

Name or Initials of Participant..... ID Code .....

Participants'Signature or Thumbprint .....

Date:.....

INTERPRETERS' STATEMENT

I confirm that I have translated the above document describing the intent, nature, benefits, risks and procedures for the research titled "FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN CHILDREN ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUIS CHILDREN'S HOSPITAL AND GREATER ACCRA REGIONAL

HOSPITAL IN ACCRA." to the participant to the best of my ability in (□ Ga □Akan □Ewe) to his/her understanding, , and that he/she had all questions answered.

Name of Interpreter.....

Signature of Interpreter.....

Date:.....

WITNESS STATEMENT

If volunteers cannot read the form themselves, a witness must sign here:

I was present while the benefits, risks and procedures of the above named study were read to the adolescent and his/her parent or guardian in (□ Ga □Akan □Ewe). All questions were answered and the adolescent has voluntarily agreed to take part in the research.

Name:.....

Signature OR Thumb Print ..... Date:.....

INVESTIGATOR STATEMENT

I certify that the nature and purpose, the potential benefits, and possible risks associated with participating in this research have been explained to the above individual. All questions raised have been addressed.

Researcher's name.....

Signature .....

Date.....

8.4 APPENDIX D (QUESTIONNAIRE)

FACTORS ASSOCIATED WITH MALARIA CO-INFECTION IN HIV-POSITIVE CHILDREN UNDER 5 ATTENDING SPECIAL CLINIC AT THE PRINCESS MARIE LOUISE CHILDREN'S HOSPITAL IN ACCRA.

PI – ANITA MOMO TIBBOH

QUESTIONNAIRE

CODE: _____

DEMOGRAPHY

1. Sex of child

   - Female
   - Male

2. Sex of caregiver

   - Female
   - Male

3. Date of Birth of child (DD/MM/YY) .....

4. Age of child .....

5. Age of caregiver

   - 15 - 20
   - 21 – 30
   - 31 – 40
   - 41 – 50

- 51 – 60
- Above 60

6. Highest level of education of caregiver

- None
- Primary (complete/incomplete)
- Secondary (complete/incomplete)
- Post secondary /vocational
- Tertiary
- Second degree and above

7. Relationship of caregiver to the head of the household (Tick only one)

- Head of household
- Spouse/partner
- Son/daughter
- Grandchild
- Parent
- Brother /sister
- Not related
- Employer
- Neighbour

8. Relationship of caregiver to the child (Tick only one)

- Head of household
- Grandparent
- Parent

- Brother /sister
- Aunt/Uncle/Cousin
- Legal guardian
- Informal guardian
- Not related
- If "other" describe:

9. Relationship of child to the head of the household (Tick only one)

- Son/daughter
- Grandchild
- Brother /sister
- Niece/nephew
- Ward
- If "other" describe:

DETERMINATION OF SOCIOECONOMIC STATUS

10. How many members does the household have?

- 8 or more
- 7
- 6
- 5
- 4
- 3
- 2

- 1

11. Are all household members ages 5 to 17 currently in school?

- No
- Yes

12. Can the male head/spouse read a phrase/sentence in English?

- No
- Yes

13. What is the main construction material used for the outer wall? (Tick only one)

- Un-burnt bricks, mud and poles, thatch/straw, timber, stone, burnt bricks with mud, other
- Burnt bricks with cement, or cement blocks

14. What is the type of toilet that is mainly used in your household? (Tick only one)

- None
- Private Pit /bucket/pan latrine
- Public toilet
- KVIP/WC (private)

15. What is the main fuel used by the household for cooking?

- None
- Wood, sawdust, crop residue
- Charcoal or Kerosene
- Gas or electricity

16. Does any household member own a working box iron or electric iron?

- No
- Yes

17. Does any member of your household own electronic equipment (e.g. TV, radio, computer, MP3/MP4 player, satellite dish etc.) at present? (Tick only one)

- No
- Only TV
- Radio, computer, MP3/MP4 player, satellite dish (regardless of TV)

18. How many working mobile phones are owned by members of the household?

- None
- One
- Two
- Three or more

19. Does any household member own a working bicycle, motor cycle, or car?

- None
- Only bicycle
- Motor cycle or car

KNOWLEDGE, HEALTH SEEKING BEHAVIOUR AND PREVENTION PRACTICES ON MALARIA

Basic knowledge about Malaria

20. Have you ever heard about Malaria?

- Yes
- No
- I don't Know

21. Which vector can transmit Malaria to humans? (Tick one only)

- Rat
- Dog
- Mosquito
- Fly
- Cockroach
- I don't Know

22. Malaria can be transmitted to humans by?

- Drinking contaminated water
- Eating contaminated food
- Eating a lot of mangoes
- Bite of mosquito infected with Malaria
- Coming into close contact with a Malaria patient

23. Do you think Malaria can kill you if it's untreated?

- Yes

- No
- I don't Know

24. What do you think are the most common signs and symptoms of Malaria infection? (Tick all that apply)

- High temperature/Fever
- Loss of energy
- Vomiting
- Sweating
- Headache
- Body pains
- Itching
- Loss of appetite
- Chills
- Dizziness
- Bitterness in the mouth
- I don't Know
- Other
- If "other" describe:

25. Which of these are ways to prevent and control Malaria? (Tick all that apply)

- Sleeping in bed nets
- Wearing long sleeved clothes
- Making fire and smoke
- Spraying insecticide
- Trimming bushes around the house pain

- Cleaning dark corners in the house
- I don't Know

26. When do Malaria mosquitoes feed? (Tick only one)

- Daytime
- Night time
- Both day and night time
- I don't Know

27. What personal protection measures do you use to guard against Malaria? (Tick all that apply)

- Use repellents
- Use mosquito coil
- Use herbs eg orange peels etc
- Burn cow dung
- Close windows and doors
- Gauze wire in windows
- Use mosquito nets
- Use mosquito sprays
- Do nothing
- Others (specify)

28. Does your household have bed nets?

- Yes
- No

29. If yes, who owns the available nets in this household? (Tick as many)

- Head of household
- Mother
- Children over five years
- Children under five years
- Others(Specify)

30. Are all these bed nets being used?

- Yes
- No
- Don't know

31. If no to question 28, why? _____

Treatment seeking behaviours

32. Have you or any member of the household suffered from Malaria in the last six months (Tick only one)

- Yes
- No
- I don't Know

33. If you thought you or a member of the household had malaria, where would you seek treatment

- Health centre/clinic
- Community health worker
- Traditional healer
- Drug shop /pharmacy
- Look for local herbs

- No where
- I don't Know
- Other
- If "other" describe:

34. How soon after feeling ill would you seek treatment?

- One day(within 24 hours)
- 2-3 days
- 4-6 days
- 7 days or more

35. Do you think you have enough information about Malaria? (Tick only one)

- Yes
- No
- I don't Know

Practices towards Malaria prevention

1. Always
2. Sometimes
3. Never

36. How often do you sleep in a mosquito net?

□ [3] □ [2] □[1]

37. How often do other members of the household sleep in mosquito nets?

□ [3] □ [2] □[1]

38. How often do you check for holes/repair mosquito nets

□ [3] □ [2] □[1]

39. How often do you use mosquito repellent coils on your house?

□ [3] □ [2] □[1]

40. How often do you use anti-mosquito spray in your house?

□ [3] □ [2] □[1]

41. How often do you clean/cut bushes around your house?

□ [3] □ [2] □[1]

42. How often do you clean stagnant water near your house

□ [3] □ [2] □[1]

43. How often do you visit the health centre when you fall sick?

[3]□ [2] □[1]

HIV KNOWLEDGE (adapted from (Carey, Morrison-Beedy, & Johnson, 1997)

1. True
2. False
3. I Don't know

44. Coughing and sneezing DO NOT spread HIV.

□[1] [3]□[2]

45. A person can get HIV by sharing a glass of water with someone who has HIV

□[1] [3]□[2]

46.All pregnant women infected with HIV will have babies born with AIDS

□[1] [3]□[2]

47.People who have been infected with HIV quickly show serious signs of being infected.

□[1] [3]□[2]

48. There is a vaccine that can stop people from getting HIV.

□[1] [3]□[2]

49.A person will not get HIV if she or he is taking antibiotics.

□[1] [3]□[2]

50. Having sex with more than one partner can increase a person's chance of being infected with HIV

□[1] [3]□[2]

51. A person can get HIV by sitting in a hot tub or a swimming pool with a person who has HIV

□[1] [3]□[2]

BREASTFEEDING PRACTICE

52. Has child ever been breastfed or given expressed breastmilk?

- Ever Breastfed
- Never breastfed
- I don't know

53. For respondents never breastfed

- Mother not available
- Feeding option chosen

54. For respondents ever breastfed

- Child was exclusively breastfed for ..... months.
- Child was mixed fed

MALARIA DIAGNOSIS

55. Malaria Symptoms - In the last two weeks, has child experienced any of these symptoms? (Tick all that apply)

- High temperature
- Loss of energy
- Vomiting

- Sweating
- Headache
- Body pains
- General weakness
- Loss of appetite
- Chills
- Convulsions

DIETARY DIVERSITY QUESTIONNAIRE

Please describe the foods (meals and snacks) that your child/ward ate or drank yesterday during the day and night, whether at home or outside the home.

Start with the first food or drink of the morning. Write down all foods and drinks mentioned. When composite dishes are mentioned, ask for the list of ingredients. When the respondent has finished, probe for meals and snacks not mentioned.

MEAL	DETAILS
Breakfast	
Snack	
Lunch	
Snack	
Supper	
Snack	

When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

Guidelines for Measuring Household and Individual Dietary Diversity

Question number	Food group	Examples	YES=1 NO=0
1	CEREALS	corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)	
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots	
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (e.g. red sweet pepper)	
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as kontonmire, cassava leaves, kale, spinach	
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant, small garden eggs/turkey berries) + other locally available vegetables	

6	VITAMIN A RICH FRUITS	ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits	
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these	
8	ORGAN MEATS	liver, kidney, heart or other organ meats or blood-based foods	
9	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	
10	EGGS	eggs from chicken, duck, guinea fowl, quail or any other egg	
11	FISH AND SEAFOOD	Fresh, dried, smoked fish or shellfish (crabs, shrimps), octopus,	
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg. Groundut paste, tombrown, soya khebab, fura/fula)	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products, burkina	
14	OILS AND FATS	oil, fats, margarine or butter added to food or used for cooking	

15	SWEETS	sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes	
16	SPICES, CONDIMENTS, BEVERAGES	spices (black pepper, salt), condiments (soy sauce, hot sauce, maggi, ketchup), milo, this way, cocoa drink, tea	
17	INDIVIDUAL LEVEL	Did your child/ward eat anything (meal or snack) OUTSIDE the home yesterday?	

8.5 APPENDIX E (CLINICAL ASSESSMENT FORM)

A. HIV MANAGEMENT (FROM MEDICAL RECORDS)

1. Current HIV Staging - .....

2. Use of Trimethoprim-sulfamethoxazole (TMP-SMZ/ Cotrimoxazole/ Septrin)

   - Yes
   - No

3. Use of Antiretroviral Therapy

   - Yes
   - No

B. Malaria Testing

RDT Result	
Blood Film for Malaria Parasites	

C. NUTRITIONAL ASSESSMENT

HEIGHT (cm)	
WEIGHT (kg)	
Haemoglobin Level (g/Dl)	

GHANA HEALTH SERVICE ETHICS REVIEW COMMITTEE

In case of reply the number and date of this Letter should be quoted.

Research & Development Division
Ghana Health Service
P. O. Box MB 190
Accra
Tel: +233-302-681109
Fax + 233-302-685424
Email: ghserc@gmail.com
11th March, 2019

MyRef. GHS/RDD/ERC/Admin/App
Your Ref. No. 19/098

Anita Momo Tibboh
University of Ghana
School of Public Health

The Ghana Health Service Ethics Review Committee has reviewed and given approval for the implementation of your Study Protocol.

GHS-ERC Number	**GHS-ERC047/02/19**
Project Title	Factors Associated with Malaria Co-Infection in HIV-Positive Children Attending Special Clinic at Princess Marie-Louise Children's Hospital
Approval Date	11th March, 2019
Expiry Date	10th March, 2020
GHS-ERC Decision	**Approved**

This approval requires the following from the Principal Investigator

- Submission of yearly progress report of the study to the Ethics Review Committee (ERC)
- Renewal of ethical approval if the study lasts for more than 12 months,
- Reporting of all serious adverse events related to this study to the ERC within three days verbally and seven days in writing.
- Submission of a final report after completion of the study
- Informing ERC if study cannot be implemented or is discontinued and reasons why
- Informing the ERC and your sponsor (where applicable) before any publication of the research findings.
- Please note that any modification of the study without ERC approval of the amendment is invalid.

The ERC may observe or cause to be observed procedures and records of the study during and after implementation.

Kindly quote the protocol identification number in all future correspondence in relation to this approved protocol

SIGNED.....
DR. CYNTHIA BANNERMAN
(GHS-ERC CHAIRPERSON)

cc: The Director, Research & Development Division, Ghana Health Service, Accra