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Malaria Control among Pregnant Women in Ghana: A mixed-methods study on the Uptake of Intermittent Preventive Treatment and Insecticide Treated Mosquito Nets

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DEDICATION

To my beloved family, especially my, mother Madam Gladys A. Dery, and siblings, for their unflinching support; to my wife Pamela, and my son, Mwinkum, whom I had to leave before he was even born; to all the children of my study respondents; and to all those in the field of Disease Control who strive to reduce infection spread and disease burden, especially among disadvantaged populations, and to improve maternal and child health especially in resource-constrained settings, may our efforts result in the desired health outcomes!

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LIST OF ABBREVIATIONS

ACTs	Artemisinin-based Combination Therapies
AI	Active Ingredient
AQ	Amodiaquine
BC	Before Christ
BCE	Before the Common Era
CHN	Community Health Nurses
CHOs	Community health officers
CHPS	Community Health Planning and Service
DBI	Daffiama Bussie Issa
DDT	Dichlorodiphenyltrichloroethane
DHMTs	District Health Management Teams
DHS	Demographic Health Survey
DOT	Directly Observe Therapy
EN	Enrolled Nurses
FA	Folic Acid
FANC	Focused Antenatal Care
FGD	Focus Group Discussion
GDHS	Ghana Demographic Health Survey
GHS	Ghana Health Service
GHS	Ghana Health Service
GMP	Global Malaria Program
GMS	Greater Mekong sub-region
GSS	Ghana Statistical Service
HCs	Health Centers
HFs	Health Facilities
HIV	Human Immunodeficiency Virus
IPTp	Intermittent Preventive Therapy in pregnancy

IRR	Incidence Rate Ratios
ITNs	Insecticide Treated bed Nets
IUG	Intrauterine Growth
IUGR	Intrauterine Growth Retardation
LBW	Low Birth Weight
LDHD	Lambussie District Health Directorate
LLINs	Long Lasting Insecticide Nets
MiP	Malaria in Pregnancy
MMDAs	Metropolitan, Municipal and District Assemblies
MoH	Ministry of Health
MW	Midwives
NHRC	Navrongo Health Research Center
NMCP	National Malaria Control Program
NTD	Neural Tube Defect
OR	Odds Ratio
RDT	Rapid Diagnostic Tests
RHMT	Regional Health Management Team
SDHTs	Sub-district Health Teams
SMC	Seasonal Malaria Chemoprevention
SP	Sulfadoxine-Pyrimethamine
SVD	Spontaneous Vaginal Delivery
USAID-PMI	United States Aid - President's Malaria Initiative
UWR	Upper West Region
WHO	World Health Organization
WMHD	Wa Municipal Health Directorate

1 BACKGROUND

1.1 History of Malaria

For several epochs, malaria disease has occupied a unique place in the annals of history. The victims of the disease have ranged the socioeconomic and political divide of numerous cultures of the world, from Neolithic dwellers, early Chinese and Greeks, princes and paupers (Christophers, 1951). For over 25 centuries, the idea that malaria fevers resulted from miasmas rising from swamps persisted. It is widely held that the word malaria comes from the Italian expression mal'aria, meaning 'spoiled or bad air' (Sullivan, 2006). However, this has been disputed (Cox, 2010). The Chinese Canon of Medicine (*Nei Ching*) also discussed malaria symptoms in relation to fevers and enlarged spleens as far back as 2700 BCE (Sullivan, 2006). According to reports from the World Health Organization (WHO) and others, the protozoan disease is still the most important parasitic infection of the human species and is currently transmitted by the female *Anopheles* mosquito in 108 countries inhabited by an estimated 3 billion people (White et al., 2014; WHO, 2019). The symptoms of malaria were observed and documented in ancient Chinese medical writings as far back as 2700BC (Christophers, 1951). Five species of the genus *Plasmodium* cause all malarial infections in human beings. Even though human infections can also be caused by *Plasmodium ovale*, *Plasmodium malariae*, and, in parts of Southeast Asia, the monkey malaria *Plasmodium knowlesi*, the most cases are caused by either *Plasmodium falciparum* or *Plasmodium vivax* (Kantele & Jokiranta, 2011; White et al., 2014; Cramer, 2015). Malaria was once prevalent throughout much of the inhabited world. It was eventually eliminated from the USA and Canada, Europe, and Russia after widespread spraying with dichlorodiphenyltrichloroethane (DDT) in the frame of a global eradication program, which lasted from 1955 until 1969 (Müller, 2011). The disease, however, has since resurged predominantly

within the tropical countries from the 1970s until the end of the 20th century because of a combination of relaxation of control efforts, increasing anti-malarial drug resistance, and insecticide resistance in the mosquito vectors. Since then, prevalence has fallen again as a result of substantial increases in donor funding, improved control, and increased enthusiasm for elimination and eradication (White et al., 2014; Feachem et al., 2010; Alonso et al., 2011).

1.2 Global Epidemiology of Malaria

Malaria is caused by *Plasmodium* parasites. The parasites are spread to people through the bites of infected female *Anopheles* mosquitoes, called "malaria vectors" (Mace et al., 2019; WHO, 2019a). The main determinants of malaria transmission intensity are the density, longevity, biting habits, and mosquito vector efficiency (White et al., 2014). The bite of female *Anopheles* mosquitos occurs mainly between dusk and dawn (Alilio et al., 2004). Other comparatively rare transmission mechanisms include congenitally acquired disease, blood transfusion, sharing of contaminated needles, organ transplantation, and nosocomial transmission (Owusu-Ofori et al., 2013; Gruell et al., 2017; Mace et al., 2019). Even in tropical countries where malaria is endemic, the risk varies widely. Characteristically, arid (<1,000 mm rainfall/year) and highland (>1,500 m) areas record less malaria incidence. However, these areas are prone to epidemic malaria if climatic conditions become favourable to mosquito development (van Damme, 2004).

1.3 Global Burden of Malaria

Close to two-fifths of the world's population still lives in high malaria-endemic settings, the worse affected amongst them being the poor of the Amazon basin, Asia, sub-Saharan Africa, and other tropical regions (Arrow et al., 2004). According to WHO data, 228 million cases of malaria occurred in 2017 compared to 219 million cases in 2018 and 229 million in 2019, with over 93% of them recorded in the WHO Africa Region, followed by 3.4% in the WHO South-East Asia Region (WHO-Briefing Kit, 2020; WHO, 2019c; WHO, 2018d; Samba, 1997). For instance, 10 countries in sub-Saharan Africa (Burkina Faso, Cameroon, the Democratic Republic of the Congo, Ghana, Mali, Mozambique, Niger, Nigeria, Uganda, and the United Republic of Tanzania) accounted for about 70% of the globally estimated malaria cases and some 71% of the estimated malaria-related mortalities in 2016. This translates into nearly 154 million cases and 311,000 deaths annually in these ten high-burdened countries (WHO, 2018). Estimates from these countries demonstrate an increase in malaria cases in 2016 to 2019 compared to the previous years (World Health Ogranization, 2018; WHO, 2019c; Mace et al., 2019).

Most of all malaria-related morbidities and mortalities are caused by *P. falciparum* (White et al., 2014). Globally, about 3.3% of all estimated malaria cases resulted from *P. vivax,* with over 50% of all *P. vivax* malaria occurring in the WHO South-East Asia Region. *P. vivax* parasite accounts for some 75% of malaria cases in the WHO Region of the Americas (WHO, 2019f). However, the high burden could partly be a result of misdiagnoses, since health facilities in many endemic areas lack laboratory capacity, and it is often difficult clinically to distinguish malaria from other infectious diseases (Samba, 1997). Factors influencing the persistent rise in cases of malaria in these high-burden areas are many and varied, including population growth, epidemiologic and

socio-demographic risk factors, the intensity of malaria transmission, suboptimal malaria intervention coverage, and poor access to care (World Health Organization, 2018). In 2018, about 85% of all malaria cases globally were in 19 countries: India and 18 African countries, with Nigeria accounting for about 25% of the total morbidity burden (WHO, 2019f). Significant increases were observed in the Democratic Republic of the Congo (12%), Ghana (8%), Uganda (5%), and Côte d'Ivoire, Mozambique and Niger (4% each) (WHO, 2019f). However, of the 19 high-burdened countries, India reported the most considerable absolute reductions in cases of falciparum malaria, with 2.6 million fewer cases in 2018 than in 2017 (WHO, 2019f). From 2010 to 2018, the global malaria incidence rate (i.e. the number of cases per 1000 population) reduced by about 20%; it fell from 71 in 2010 to 57 in 2018 (WHO, 2019f). The WHO South-East Asia Region recorded the highest reductions in incidence, primarily due to reductions in India, Indonesia and countries in the Greater Mekong Sub-Region (GMS) (WHO, 2019f). In settings where malaria transmission is stable, very young children and pregnant women are the population groups at the highest risk for malaria disease and fatalities (Samba, 1997; WHO, 2016; WHO, 2019c; Rogerson & Meshnick, 2019). Most children experience their first malaria infections during the first year or two of life when they have not yet acquired adequate clinical immunity – which makes these early years particularly dangerous. Ninety per cent of all malaria deaths in Africa occur in young children (Samba, 1997). Findings of recent studies in Africa seem to have arrived at a common observation that malaria causes at least 20% of all deaths in children under 5 years of age (Samba, 1997). *P. falciparum* is the most important single infectious agent causing death among young children in malaria endemic areas, compared to similar proportion of deaths resulting from respiratory disease caused by a variety of infectious agents (Samba, 1997).

1.4 Global Malaria Control

1.4.1 Vector Control

Vector control using insecticide-treated bed nets (ITNs) and indoor residual spraying (IRS) is one of the key measures of preventing malaria transmission over the years and has proven to reduce malaria transmission when coverage is sufficiently high (WHO, 2019a). Increasing the coverage and use of long-lasting insecticide bed nets (LLINs) is now the most preferred malaria vector control strategy in malaria-endemic countries, according to WHO recommendations (Organização Mundial da Saúde, 2019; WHO, 2020; Gari & Lindtjørn, 2018).

1.4.1.1 Insecticide Treated Bed Nets (ITNs)

An ITN is a mosquito net that repels, disables, and or kills mosquitoes that come into contact with the insecticide on the netting material (WHO/GMP, 2008). Generally, every mosquito net provides a physical barrier between the mosquito and the individual(s) using the nets. There are two categories of ITNs - conventionally treated nets and LLINs. A conventionally treated net is a mosquito net that has been treated by dipping in a WHO-recommended insecticide. The net should be re-treated after three washes, or at least once a year to ensure its continued insecticidal effect (WHO/GMP, 2008). The LLIN, on the other hand, is a factory-treated mosquito net made with netting material that has insecticide incorporated within or bound around the fibres. Until a few years ago, all WHO-recommended ITNs contained only pyrethroid insecticide as the active ingredient (AI). Pyrethroid-only LLINs are the current standard of care across most malaria-endemic countries (WHO Global Malaria Programme, 2020). By reducing the vector population in this way, ITNs, when used by a majority of the target population, provide protection for all people in the community, including those who do not sleep under nets (mass effect) (WHO/GMP, 2008).

1.4.1.2 Global Picture of Insecticide Treated Mosquito Nets

The use of insecticide-treated bed nets (ITN)/long-lasting insecticide-treated nets (LLIN) has been one of the most effective public health measures for the control and prevention of malaria, especially among the two most vulnerable groups of people - under-five children and pregnant women (WHO-HTM-GMP, 2017; Ahmed et al., 2011; Khanam et al., 2018). Despite some documented evidence of developing vector-resistance to pyrethroids nets (Alonso et al., 2011; WHO-HTM-GMP, 2017; Gleave et al., 2018), it is reported that the correct and long-lasting usage of the ITNs can reduce clinical malaria burden in pregnancy between 50-80% (Korenromp et al., 2003; Onyebuchi *et al.*, 2014). However, to achieve an over 50% reduction in clinical malaria (in pregnancy), an overall population usage of >70% needs to be achieved, especially in tropical settings (Aluko *et al.,* 2012; Korenromp et al., 2003). Countries with ongoing malaria transmission are still encouraged to continue to develop and implement effective insecticide resistance management strategies (WHO-HTM-GMP, 2017). The WHO further highlights that even though a promising pipeline of new anti-mosquito tools is currently under development, there is still the urgent need for new and improved control tools to accelerate progress towards global malaria targets (WHO-HTM-GMP, 2017).

In order to realize the full potential of LLINs, high coverage rates (>90%) are needed (WHO/GMP, 2008). The global malaria program (GMP) recommends full coverage of all people at risk in areas targeted for malaria prevention through ITNs, including LLINs. In endemic areas with intense malaria transmission (stable malaria), all infants at their first immunization and all pregnant women as early as possible in pregnancy should receive one LLIN through immunization and antenatal care visits (WHO/GMP, 2008). Even though the ultimate goal is high levels of ITN use

to confer protection against infected mosquitoes, it is common knowledge that any assessment of ITN use must be understood in the context of ITN availability (Koenker et al., 2018). Usually, the minimum target for universal coverage to be considered achieved is 80% both for access (ownership) and use (Koenker et al., 2018). However, despite nearly a decade of universal coverage campaigns, no country has achieved a measured level of 80% of households owning 1 ITN for two people (Koenker et al., 2018).

1.4.1.3 ITN Situation in Sub-Saharan Africa

ITN coverage rates in the general population of SSA have been relatively low over the past one-and-half decades, ranging from less than 40% in 2007 (Noor et al., 2009) to about 56% (World Health Organization, 2010) but with country-specific differences (Korenromp et al., 2003). Recent data from across the malaria belt in Africa report that access to ITNs in the general population ranged from 57.3% in Madagascar in 2011 to 78.8% in Uganda in 2014, while the proportion of households owning at least 1 ITN for two people across the same countries within same period ranged from 31.1% to 62.0% (Koenker et al., 2018).

Significant gains have been made over the years through the distribution of ITNs as part of the implementation of malaria prevention measures in pregnancy across SSA. These anti-malarial measures have resulted in a reduction in the incidence of malaria and its consequences, such as maternal anaemia, stillbirths and intrauterine growth (IUG) restriction (Desai et al., 2018; Singh et al., 2013b). Most malaria-endemic nations across Africa have implemented these policies for distributing ITNs to pregnant women through a mix of mechanisms, but coverage as well as usage remain a major challenge and are still well below the targets (Singh et al., 2013b; Eisele, *et al.,*

2009; Sangaré, *et al.,* 2012). This is probably due to the fact that there is generally low (43.4%) coverage of households with enough ITNs for every occupant (World Health Organization, 2010), and particularly, only 17% coverage among pregnant women in SSA (van Eijk, *et al.,* 2011). Usage of ITNs among pregnant women across SSA has increased from about 18% in 2007 to 42% in 2010 but with significantly high usage in areas with both a high disbursement of funds for malaria control and a lower per-head GDP (WHO, 2018b). Generally, challenges regarding sufficient coverage and usage of ITNs among general and vulnerable populations are well documented to include significant problems with infrastructure, public service organization, funds and leadership (Müller et al., 2008; WHO, 2018b).

1.4.1.4 Indoor Residual Spraying (IRS)

Another effective tool to rapidly reduce transmission of malaria is the IRS. The IRS involves the use of an environmentally friendly and of long residual activity insecticide to spray the inside of housing structures, at a maximum of twice annually (WHO, 2019b). The success of the IRS preventive measure also relies on a high level of coverage to confer significant community protection. However, there is a reduction in IRS protection, from 5% in 2010 to 3% in 2017 across all WHO regions (WHO, 2019b). It is recommended to the national malaria control programs of respective countries that the selection of insecticides for IRS should be based on the residual efficacy of the insecticide, and the local situation specific to the country, under consideration of current information on insecticide resistance, the type and safety of the surface to be sprayed, and the cost involved (WHO, 2019b). In the absence of good alternatives, many countries still rely on insecticides for vector control (Raghavendra et al., 2011). Other emerging vector control measures include bacterial pesticides, insect growth regulators,

biocontrol agents, vaccines, environmental management, and natural plant products (Raghavendra et al., 2011; Karunamoorthi, 2011; Killeen et al., 2017).

1.4.2 Malaria Case Management (MCM)

The MCM is a recommended design that aims at providing guidance on all aspects of malaria case management. MCM includes diagnostic testing, treatment of uncomplicated and severe malaria, management of malaria at primary health care and community levels, chemoprophylaxis, monitoring anti-malarial drug resistance, and development and updating national guidelines (WHO, 2012a ; Tseroni et al., 2020). The chemoprophylaxis extends to include the seasonal malaria chemoprevention (SMC) and the intermittent preventive therapy in pregnant women, as discussed in previous sections, and treatment with artemisinin-based combination treatments (ACTs). The WHO recommends that malaria-endemic countries should consider strategies for MCM an integral part of national malaria control programmes (SPRING-USAID, 2017). However, these strategies must be based on sound epidemiology specific to the area, taking into consideration the most at-risk populations as well as the seasonality of malaria. Such at-risks populations to be considered include especially children less than five years and pregnant women, residents of certain geographical areas, and occupational risk groups (farmers, forests workers).

Additionally, it is significant to consider the knowledge about the local pattern of resistance of parasites to anti-malarial drugs in planning MCM programs (WHO, 2009a). Generally, ACTs are considered the best current treatment for uncomplicated falciparum malaria except during the first trimester of pregnancy. Thus, the accessibility to populations at risk and rational use must be ensured (WHO, 2009a). Diagnosis must, however, follow the current WHO-formulated malaria treatment guidelines: it should be parasite-based for older children and adults in all malarial settings and clinical diagnosis for children under five years of age in areas of high transmission.

On the other hand, treatment of severe or complicated malaria should start with intravenous or intramuscular injections of artesunate until the patient can tolerate oral therapy with an ACT (SPRING-USAID, 2017). Malaria resulting from other species may require different treatments such as parenteral quinine, artesunate or artemether, depending on anti-malarial resistance in the area (SPRING-USAID, 2017; WHO, 2009a).

1.5 Malaria in Pregnancy

1.5.1 Burden

The problem of malaria infection in pregnant women was initially described nearly 65 years ago (Steketee et al., 2001; Wickramasuriya, 1938). The world has continuously witnessed unacceptably high pregnancy-related diseases and deaths over the years (WHO, 2017b). According to the WHO, an estimated 303,000 pregnancy-related mortalities occurred in 2015, 2.7 million babies died during the first 28 days of life, and 2.6 million were stillborn (WHO, 2016a). Malaria in pregnancy (caused by both *P. falciparum* and *P. vivax*) is also responsible for indirect mortality from abortion and intrauterine growth retardation, which increases infant mortality (White et al., 2014). The disease poses a significant public health challenge in pregnancy, with substantial risks for the pregnant woman, her fetus, and the newborn child (WHO, 2017a; Schantz-Dunn & Nour, 2009; Chaponda et al., 2015). Globally, about 11 million pregnant women exposed to malaria infections in 2018 delivered about 872,000 children with low birth weight (16% of all children with low birth weight in those countries), with West Africa having the highest prevalence of low birthweight children due to malaria in pregnancy (WHO, 2019e). The disease may contribute directly to about 25% of all maternal deaths in endemic areas (Schantz-Dunn & Nour, 2009). Malaria-associated maternal illness and low birth weight is primarily the result of *P.*

falciparum infection and occurs predominantly in Africa (WHO, 2017a). However, the risks and complications of the infection in pregnancy vary, depending on whether low or high transmission zone (WHO, 2017a; Rogerson, 2017). In areas of high transmission where levels of acquired immunity tend to be high, *P. falciparum* infection is mostly asymptomatic in pregnancy. Nevertheless, the parasites may still be present in the placenta and eventually contribute to maternal anaemia even in the absence of documented peripheral parasitaemia (WHO, 2017a). The parasite may be accounting for about 70% intrauterine growth retardation (IUGR), among other birth complications (Tegegne et al., 2019). Both placental parasitaemia and maternal anaemia can result in low birth weight, significantly contributing to infant mortality. In high-transmission settings, the adverse effects of *P. falciparum* infection in pregnancy are most pronounced for women in their first pregnancy (WHO, 2017a). In low-transmission settings, malaria in pregnancy is associated with anaemia, an increased risk of severe malaria: It may lead to spontaneous abortion, stillbirth, prematurity, and low birth weight. Women of reproductive age usually have a relatively low level of acquired immunity to malaria. In such areas, all pregnant women, regardless of the number of times they have been pregnant, become highly vulnerable to malaria infection (WHO, 2017a). The median prevalence of peripheral (at antenatal care clinics) and placental parasitaemia in low-transmission African settings was 13·7% and 6·7%, respectively (Tegegne et al., 2019). This supports earlier observations that, even though there is naturally high malaria incidence across SSA and other endemic areas, misdiagnosis could be contributing to the high number of cases recorded (Samba, 1997). *P. falciparum* infections during pregnancy in Africa rarely result in fever and therefore remain frequently undetected and untreated (Desai et al., 2007). Meta-analyses of intervention trials suggest that successful prevention of these infections reduces

the risk of severe maternal anaemia by 38%, low birthweight by 43%, and perinatal mortality by 27% among paucigravidae (Desai et al., 2007).

In malaria-endemic areas, it is estimated that a significant proportion (25%) of pregnant women are infected with malaria, with the highest risk for infection and morbidity in primigravidas, adolescents, and those co-infected with HIV (Schantz-Dunn & Nour, 2009; Rogerson, 2017; Chaponda et al., 2015). This is because HIV increases the risk of malaria and its adverse effects, particularly in multigravidae. Recent observational studies show that placental infection almost doubles the risk of malaria infection and morbidity in infants born to multigravidae (Desai et al., 2007). The second-trimester pregnant women appear to suffer the highest infection rate, supporting the need for antepartum care as part of malarial prevention and treatment efforts (Schantz-Dunn & Nour, 2009).

1.5.2 Malaria Control Measures in Pregnancy

The WHO recommends a three-way package of interventions for the prevention and treatment of malaria during pregnancy:

- The use of insecticidal treated bed nets/long-lasting insecticidal nets (ITNs/LLINs)
- Intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine (SP), as part of antenatal care services in all areas with moderate to high malaria transmission in Africa, and

- Prompt diagnosis and effective treatment of malaria infections with artemisinin-based combination therapies (ACTs) (Tegegne et al., 2019; WHO, 2017a; Rogerson, 2017; Desai et al., 2018).

The IPTp-SP and ITN programs are integrated and delivered to pregnant women through the structured antenatal care service policies in the countries' health systems. Respective countries are expected to adopt the WHO ANC policy following their local population dynamics and health infrastructural capacities (WHO, 2017a; World Health Organization, 2010; WHO, 2012b; World Health Organization, 2018; Asah-Opoku et al., 2019; Afaya et al., 2020). The requirements of the IPTP-SP program as well as the recommended and adopted ANC schedules, are detailed below in the following passages.

1.5.2.1 Intermittent Preventive Treatment in Pregnancy (IPTp) with Sulfadoxine- Pyrimethamine (SP)

IPTp with SP (IPTp-SP) remains effective in preventing the adverse consequences of malaria on maternal and fetal outcomes in areas where a high proportion of *P. falciparum* parasites carry a quintuple mutation associated with *in vivo* therapeutic failure to SP (WHO, 2012b). IPTp reduces maternal malaria episodes, maternal and fetal anaemia, placental parasitaemia, low birth weight, and neonatal mortality. Furthermore, all pregnant women should receive iron and folic acid supplements as a part of routine antenatal care (WHO, 2017a). A Lancet study reported that 83% of 47 countries studied had adopted and implemented the WHO malaria IPT policy. However, only 25% of pregnant women in these countries received at least one dose of treatment (Brieger, 2012; Thiam, Kimotho, & Gatonga, 2013). Coverage of IPTp was 55% lower than the Abuja 2000 target for 2010 and even worse in high-transmission areas of malaria (Thiam et al., 2013).

According to the 2017 World Malaria report, 36 SSA countries adopted the policy, out of which 23 reported a 19% IPTp-SP coverage of at least three doses in 2016 compared to 18% in 2015 and 13% in 2014 (World Health Organization, 2010). Preliminary data from recent observational studies have suggested reduced effectiveness of SP for IPTp in Malawi, the first country where IPTp-SP was implemented in 1993 (Feng et al., 2010; WHO, 2012b). Also, there is growing concern over the decreasing effectiveness of the 2-dose regimen of SP for IPTp in other countries with a high level of resistance to SP, especially in Eastern and Southern Africa, regions that also carry the highest incidence of HIV in the world (UNAIDS/WHO, 2010; WHO, 2012). The effect of a high level of SP resistance on IPTp effectiveness, including the significance of the dhps 581 codon mutation, should be further investigated (WHO, 2012b). A review of 7 clinical trials conducted in Africa in areas of stable transmission and different levels of SP resistance revealed that three or more doses of IPTp-SP yielded better clinical outcomes for the mother and the newborn than the standard two doses of IPTp-SP in all gravidae and HIV groups (WHO, 2012; WHO, 2014). The World Health Organization recommends a schedule of four antenatal clinic visits, with three visits after quickening (WHO, 2012b). The WHO 2012 Evidence Review Report on IPTp-SP made the following recommendations (WHO, 2012b):

- The first IPTp-SP dose should be administered as early as possible during the 2nd trimester of gestation.
- Each SP dose should be given at least one month apart from the other and up to delivery time.
- The last dose of IPTp with SP can be administered late (after 36 weeks) in the 3rd trimester of gestation without safety concerns.
- IPTp should be administered as directly observed therapy (DOT).
- SP can be given on an empty stomach.
- Folic acid at a daily dose equal or above 5mg should not be given concomitantly with SP as this counteracts its efficacy as an anti-malarial.
- SP is contraindicated in women receiving cotrimoxazole prophylaxis.

1.5.2.2 Antenatal Care (ANC) Policy and Service

While substantial progress has been made over the past 20 years, increased access to and use of higher-quality health care during pregnancy and childbirth can curb many preventable deaths and diseases, as well as improve women's and adolescent girls' experience of pregnancy and childbirth (WHO, 2017b). Globally, however, only 64% of women received antenatal care at least four times throughout the lifespan of their pregnancy (WHO, 2017b). The importance of ANC service to safe motherhood cannot be overemphasized: it entails systematic medical assessment of the pregnant woman from conception through to delivery either by standard spontaneous vaginal delivery (SVD) or via elective caesarean section (Asah-Opoku et al., 2019). ANC provides both preventive and curative health services for the pregnant woman and the fetus through the identification and management of risks associated with poor maternal and perinatal outcomes (Cunningham & Gary, 2014). Primarily, a pregnant woman's 'contact' with her antenatal care provider should be more than just a 'visit' – it should be the provision of care and support throughout pregnancy (WHO, 2017b). Thus, ANC should ensure a safe outcome of every wanted pregnancy for the baby and for the mother (Mbuagbaw et al., 2014). The main types of antenatal care are traditional and focused antenatal care (FANC) (Asah-Opoku et al., 2019).

1.5.2.3 The Traditional ANC

The traditional approach to antenatal care was introduced through social reform programs in the United States and was adopted in 1978 by the WHO as the risk-based approach to antenatal care, with the aim to improve the quality and outcome of care (Oshinyemi T. et al., 2018). The traditional ANC, also known as the orthodox model of ANC, is structured into monthly visits for the first six months of gestation, then a visit every two to three weeks for the next two months, and then weekly

visits thereafter until delivery (Villar et al., 2001a). The model demands the pregnant women frequent visits to the antenatal clinic for regular clinical assessment. Thus, it consumes more time, more resources and is also centred on quantity rather than the quality of care (WHO, 2015; Oshinyemi T. et al., 2018). It operates on the assumption that the more the number of ANC visits a pregnant woman makes, the more favourable the outcome of that pregnancy (Oshinyemi T. et al., 2018). As such, an average of up to 16 ANC visits is expected in the traditional model, regardless of their low or high-risk status. Dowswell and colleagues recommend that fewer ANC visits, no matter how comprehensive, is associated with an increase in perinatal mortality, particularly in resource-poor settings compared to standard care (Dowswell et al., 2015). This suggests that subsequent ANC policy revisions should focus on monitoring the fetal and neonatal outcomes, especially in settings where the standard number of visits is already low (Dowswell et al., 2015). In efforts to address the practical challenges with the traditional model, the WHO instituted the FANC in 2002 (Villar et al., 2001b; WHO, 2002; Kearns et al., 2014; Oshinyemi T. et al., 2018; Mchenga et al., 2019).

1.5.2.4 The focused ANC model (FANC)

Unlike the traditional model of ANC, the FANC emphasizes the quality of antenatal care than the frequency of visits, focuses on the individual women rather than group-based-risk categorization, to identify warning signs of any complications early (Oshinyemi T. et al., 2018). The FANC service model fully informs the husband and the woman of the potential complications, birth preparedness, postnatal care and planning for future child spacing/childbirth - makes pregnancy a family responsibility (Oshinyemi T. et al., 2018). It recommends pregnant women to make an average of four (4) ANC visits by their date of delivery (Birungi et al., 2006; Oshinyemi T. et al.,

2018; Lungu et al., 2011; Mchenga et al., 2019). The first ANC visit is scheduled to take place within the first 12 weeks of pregnancy (Asah-Opoku et al., 2019; Yaya et al., 2017), the second around 26 weeks, the third around 32 weeks, and the fourth between 36 and 38 weeks of gestation (World Health Organization, 2018). After that, women are advised to return to ANC at 41 weeks of gestation or sooner if they experience danger signs (World Health Organization, 2018). However, the WHO regularly institutes efforts to improve the quality of antenatal care and reduce maternal and perinatal mortality among all populations, including adolescent girls and those in hard-to-reach conflict settings of the world (WHO, 2017b). To achieve this goal, the WHO revised its FANC policy guidelines from four to eight visits because the four visits were also observed to provide pregnant women with inadequate contact with healthcare practitioners (WHO, 2017b; World Health Organization, 2018). Consequently, pregnant women are currently recommended to have their first ANC contact within the first 12 weeks' gestation, with subsequent contacts at 20, 26, 30, 34, 36, 38 and 40 weeks' gestation (WHO, 2017b). The revised ANC policy includes the following recommendations:

- A minimum of eight contacts is recommended to reduce perinatal mortality and improve women's experience of care.
- Counselling about healthy eating and keeping physically active during pregnancy.
- Daily oral iron and folic acid supplementation with 30 mg to 60 mg of elemental iron and 400 µg (0.4 mg) folic acid for pregnant women to prevent maternal anaemia, puerperal sepsis, low birth weight, and preterm birth.
- Tetanus toxoid vaccination is recommended for all pregnant women, depending on previous tetanus vaccination exposure, to prevent neonatal mortality from tetanus.
- One ultrasound scan before 24 weeks gestation (early ultrasound) is recommended for pregnant women to estimate gestational age, improve detection of fetal anomalies and multiple pregnancies, reduce the induction of labour for post-term pregnancy, and improve a woman's pregnancy experience.

- Health-care providers should ask all pregnant women about their use of alcohol and other substances (past and present) as early as possible in the pregnancy and at every antenatal visit.

1.5.2.5 Anaemia in Pregnancy and Folic Acid Supplementation

Anaemia is a multi-causal disorder that requires a holistic approach for its prevention and treatment (WHO, 2009b). Even though iron deficiency and infections are the most typical factors that cause anaemia, others include nutritional deficiencies of vitamin A, vitamin B12, folate and riboflavin, as well as thalassemia and hemoglobinopathies (WHO, 2009b). A woman's nutritional status, especially before and during pregnancy, is a key determinant of fetal growth and development. Malnutrition of any kind in a woman before conception and the early pregnancy (up to 3 months gestation), could result in an increased risk for adverse pregnancy outcomes. Therefore, the periconceptional period is considered an essential time for interventions that promote maternal health and thereby increase the likelihood of positive pregnancy outcomes (CDC, 2018; WHO, 2019c). Congenital disabilities, or congenital malformations, are structural or functional abnormalities present from birth and can be caused by several factors, including micronutrient deficiencies. Neural tube defects such as spina bifida are among the most common congenital malformations (WHO, 2019d). Current evidence suggests that folic acid supplementation in the periconceptional period, either alone or in combination with other vitamins and minerals, can prevent neural tube defects (WHO, 2019d). Consequently, the WHO recommends that all women, from preconception until the end of their first gestation, take a folic acid supplement (400 µg folic acid daily) (CDC, 2018; WHO, 2019c). Additionally, women who have had a fetus diagnosed as affected by a neural tube defect or have given birth to a baby with a neural tube defect should, among other measures:

- receive information on the risk of recurrence.

- be advised on the protective effect of periconceptional folic acid supplementation.
- be offered high-dose supplementation (5 mg folic acid daily); and
- be advised to increase their food intake of folate.

However, in populations where the daily iron is not acceptable due to side-effects, and with anaemia prevalence among pregnant women of less than 20%, intermittent oral iron and folic acid supplementation with 120 mg of elemental iron and 2800 µg (2.8 mg) of folic acid once weekly is recommended for pregnant women to improve maternal and neonatal outcomes (WHO, 2019d).

1.5.2.6 Antenatal Care Policy and Service in Ghana

The Ghana Health Service ANC policy initially adopted the traditional version (Birungi et al., 2006) until 2002. The country then adopted FANC in 2002 and recommended that the first ANC visit occur before the 16th week of gestation (Asah-Opoku et al., 2019). The second and third visits should occur between 20 to 24 weeks and 28 to 32 weeks, respectively, while the fourth visit should be within 36 to 40 weeks (Birungi et al., 2006). Even though the WHO has adjusted the number of recommended ANC visits from 4 to 8 (World Health Organization, 2018), Ghana still maintains the original FANC policy (Appiah et al., 2020; Afaya et al., 2020). The WHO recommends IPTp-SP to be given at each scheduled ANC visit but only from 16 weeks of gestation onwards when quickening starts and subsequent doses be spaced one month apart (WHO, 2018a). This means that ANC facilities and staffs who strictly integrate the IPTp-SP policy into the FANC schedule will result in pregnant women receiving a maximum of only SP3 by their due date of delivery because the new FANC model encourages few ANC visits (Birungi et al., 2006). Thus, Ghana still maintains the original FANC model, which encourages more ANC visits by date of delivery (Figure 1).

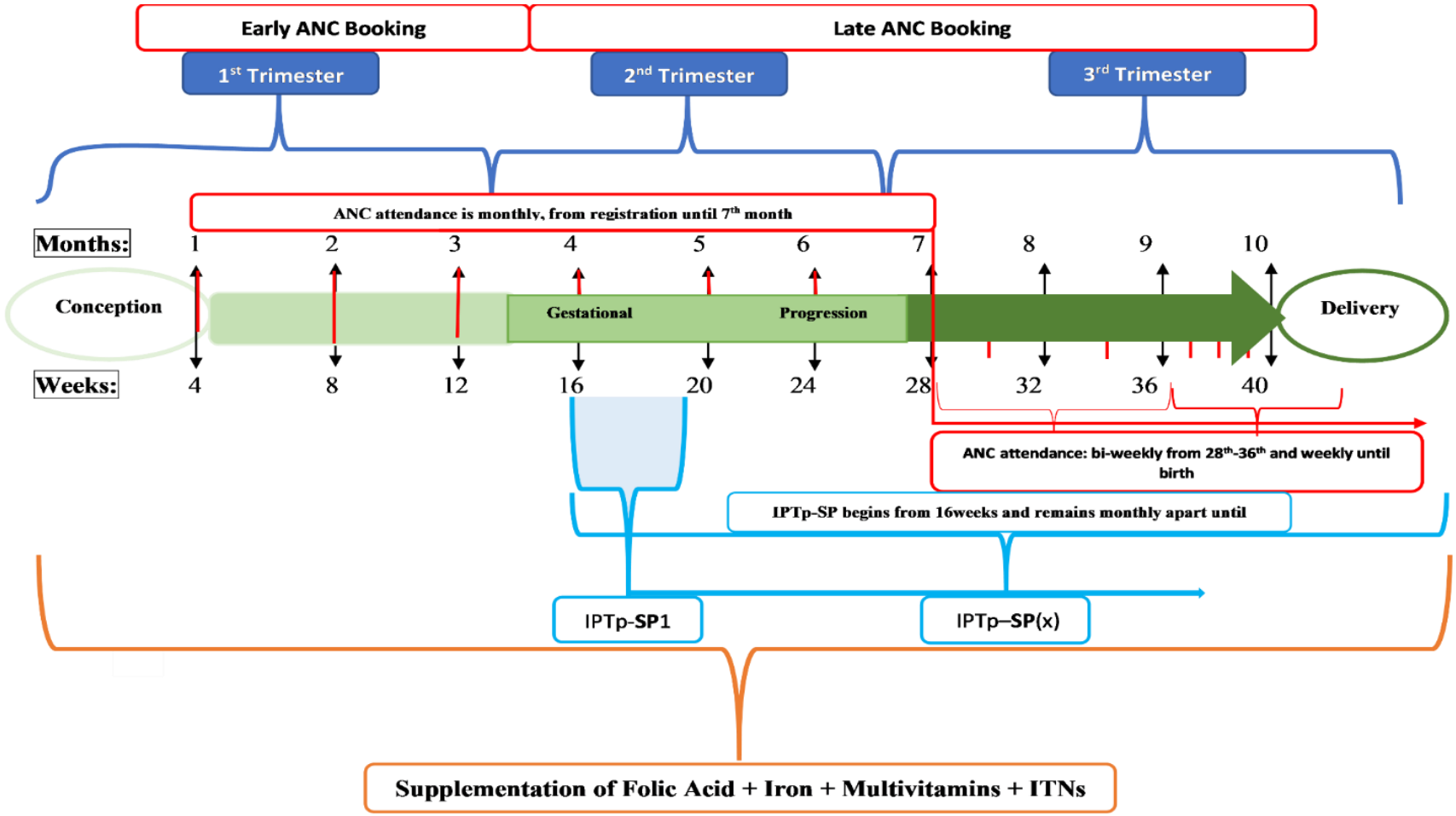


Figure 1: Synchronized Concepts of gestational progression and timing of SP, folic acid, Iron, multivitamins and ITN supplementation

Source: Author's Construct (November 2020)

Figure 1: Synchronized concepts of gestational progression and timing of SP, folic acid, iron, multivitamins and ITN supplementation

1.6 Malaria in Ghana

1.6.1 Epidemiology

Malaria is endemic in Ghana. The highest transmission rates occur in the country's Savannah regions: Northern, Upper West, Upper East, and Savannah regions. Up to 60% of clinical cases occur from July to October (Medicines for Malaria Venture, 2017). Ghana is among the 15 countries most burdened with malaria globally, contributing 3% of global malaria cases and mortalities (Medicines for Malaria Venture, 2017). The WHO indicates that 100% of Ghana's population is at risk of malaria (WHO Report, 2017). The country recorded 500,000 new malaria cases in absolute numbers in 2018, representing a 5% increase over the 2017 records (Medicines for Malaria Venture, 2017; WHO, 2019c). About a fourth (21%) of all childhood malaria fatalities were observed in the Northern Region, according to Ghana Health Service (PMI-AIRS Ghana, 2017). Compared to levels two years earlier, new cases represent a 3% increase while mortalities rather fell by 12% (Medicines for Malaria Venture, 2017; WHO, 2019c). However, the recently adopted national 2015–2020 Strategic Action Plan aims at a 75.0% reduction in the burden of malaria (Awine et al., 2017).

1.6.2 Malaria Burden in Ghana

Ghana remains one of the world's malaria-endemic countries despite tremendous preventive efforts and noteworthy progress (Shretta et al., 2020). Over the past 15 years, malaria morbidity and mortality in the country have, respectively, decreased by over 50% and 65%. With over a decade of policy development and improved control interventions, malaria deaths among children under five years of age reduced from 14.4% in 2000 to 0.6% of all under-five morbidities in 2012 (Awine et al., 2017). Nevertheless, the disease continues to exert a heavy public health burden on the

country, accounting for about a fourth of outpatient attendances (OPD), 23% of all inpatient admissions, and about one-third of under-five mortalities (PMI-AIRS Ghana, 2017; Shretta et al., 2020). Data show that over 90% of malaria morbidity in the country is accounted for by the *P. falciparum* (Shretta et al., 2020). Aside from the northern parts of Ghana, where it is seasonal, malaria is perennial (Medicines for Malaria Venture, 2017; WHO, 2019c).

1.6.3 Malaria Control Measures in Ghana

1.6.3.1 Distribution and Use of ITNs

In Ghana, substantial quantities of mosquito nets have been distributed as part of the country's efforts to improve access to ITN and achieve universal coverage of ITN use (Manu et al., 2017a). Before 2010, distributions of ITNs in Ghana were initially done through either a voucher scheme, maternal and child health campaigns by subsidizing the cost, or selling them at the total cost (Manu et al., 2017a). In 2010 however, the country introduced the free mass distribution initiative to achieve universal coverage by 2012. The mass distribution initiative was augmented by a door-to-door distribution and the '*Hang your net* campaign' to achieve universal coverage in terms of ownership and use (Manu et al., 2017a; USAID-PMI, 2016). As a result, about 80% of the general Ghanaian population is reportedly covered by ITN in 2016 (World Health Organization, 2010) even though some considerable regional variations still exist. According to the 2019 malaria indicator survey, 74% of households in Ghana own at least one ITN, and 52% of households have at least one ITN for every two people. About 7 in 10 people (67%) now have access to an ITN from the latest mass distribution campaign in 2018. This means that 67% of the country's population could sleep under an ITN if two people used every ITN in a household. However, usage has remained below targets: 43% of the household population, 54% of children under age 5, and 49% of pregnant women slept under an ITN the night before the survey (Ghana Statistical Service,

2020). Coverage of ITNs among Ghanaian pregnant women in particular has remained in the range of 2.7% to 50% over the years (Kweku, *et al.,* 2007; GSS-DHS, 2009; Ghana Statistical Service, 2017; Manu et al., 2017a). The 2014 Ghana Demographic Health Survey reported that 43% of all pregnant women nation-wide and only 35.8% in the Upper West Region slept under ITNs (GSS-DHS, 2015). However, the current statistics indicate that the coverage of ITNs among pregnant women nationwide increased slightly from 32.8% in 2015 to 40.8% in 2016 (GHS-NMCP, 2016) compared to ITN use among pregnant women which increased from around 33% in 2011 to 50% in 2016 (Manu et al., 2017a; Medicines for Malaria Venture, 2017; USAID-PMI, 2020).

1.6.3.2 Use of Indoor Residual Spraying

The Indoors Residual Spraying campaign has been implemented in Ghana under the support of the United States Presidents' Malaria Initiative (PMI) since 2006 (Gogue et al., 2020) and two years later in the northern part of the country (PMI-AIRS Ghana, 2017; Suuron et al., 2020; Abuaku et al., 2018). The campaign is currently implemented across many of the northern areas of Ghana where malaria is a major public health concern and the ongoing ITN intervention (Abuaku et al., 2018).

There have been substantial strides in the fight against malaria due to the IRS campaign, together with other malaria control interventions (PMI-AIRS Ghana, 2017). Following the introduction of the PMI over a decade ago, the country has recorded about a 30% reduction in all-cause mortality rates for children under five (PMI-AIRS Ghana, 2017). Evidence from surveys across the country in 2016 further shows that the prevalence of malaria parasite in children under five years of age in the country's northern regions has declined to less than 40% (Gogue et al., 2020). However, stronger evidence is still needed to confirm the exact impact of the IRS initiative on malaria-related morbidity and mortality (Gogue et al., 2020).

1.6.4 Malaria interventions in the Upper West Region

Nonvignon et al. (2016), in a recent study on seasonal malaria chemoprevention, classified the region under the northern savannah malaria epidemiologic zone alongside its three neighbouring regions of Upper East, Northern, and Savannah regions (Figure 3). Averagely, it has about seven months long malaria transmission season, running from April to November, with about 60% of the cases occurring within July to November (Nonvignon et al., 2016).

1.6.4.1 Distribution and use of ITNs in the Upper West Region

The region has made tremendous efforts in rolling out malaria intervention programs on IPTp-SP (Table 1) and distribution of LLINs/ITNs, especially to pregnant women (Table 2) (GHS_UWR, 2020), as detailed below. The study area recorded over 50% decrease in ITN coverage among pregnant women from 55.5% in 2014 (NMCP, 2015) to 12.6% in 2015 (NMCP, 2016), compared to nationwide coverage of 50% (Ghana Statistical Service, 2017). Prior to this study, however, information regarding reasons for the low usage of ITNs in the study area was scanty. For the past four years, routine data indicate that only about 10% of all registered pregnant women in the region received LLINs (Table 2). Studies among pregnant women the middle belt of Ghana indicate that low uptake of ITNs is a result of inaccessibility challenges, sleep discomforts, inappropriate structures for hanging, among others (Manu et al., 2017a).

1.6.4.2 Performance of IPTp-SP in the region

Routine data from the health facilities indicate that in 2019, the study area (Figure 1) attained an IPTp-SP coverage of 51.8%, being close to the national target of 50%. The chosen districts for this study, the Wa Municipality and the Lambussie district, had recorded 53.8% and 52% coverage in 2019, respectively (Table 1).

Table 1: Pregnant women taking IPT3 by District/Municipals in UWR, 2019

District	DBI	Jirapa	Lambussie	Lawra	Nadowli	Nandom	Sissala East	Sissala West	Wa East	Wa Municipal	Wa West	UWR
IPT 3	804	1674	768	673	1239	820	1488	1247	869	3584	1218	14384
%IPT3	72	68.7	**52**	43.4	53.2	61.9	51.1	61.4	29.1	**53.8**	41.3	51.8

Source: (GHS_UWR, 2020)

Table 2: Percentage (%) of total ANC registrants given LLINs in each district (2016 - 2019)

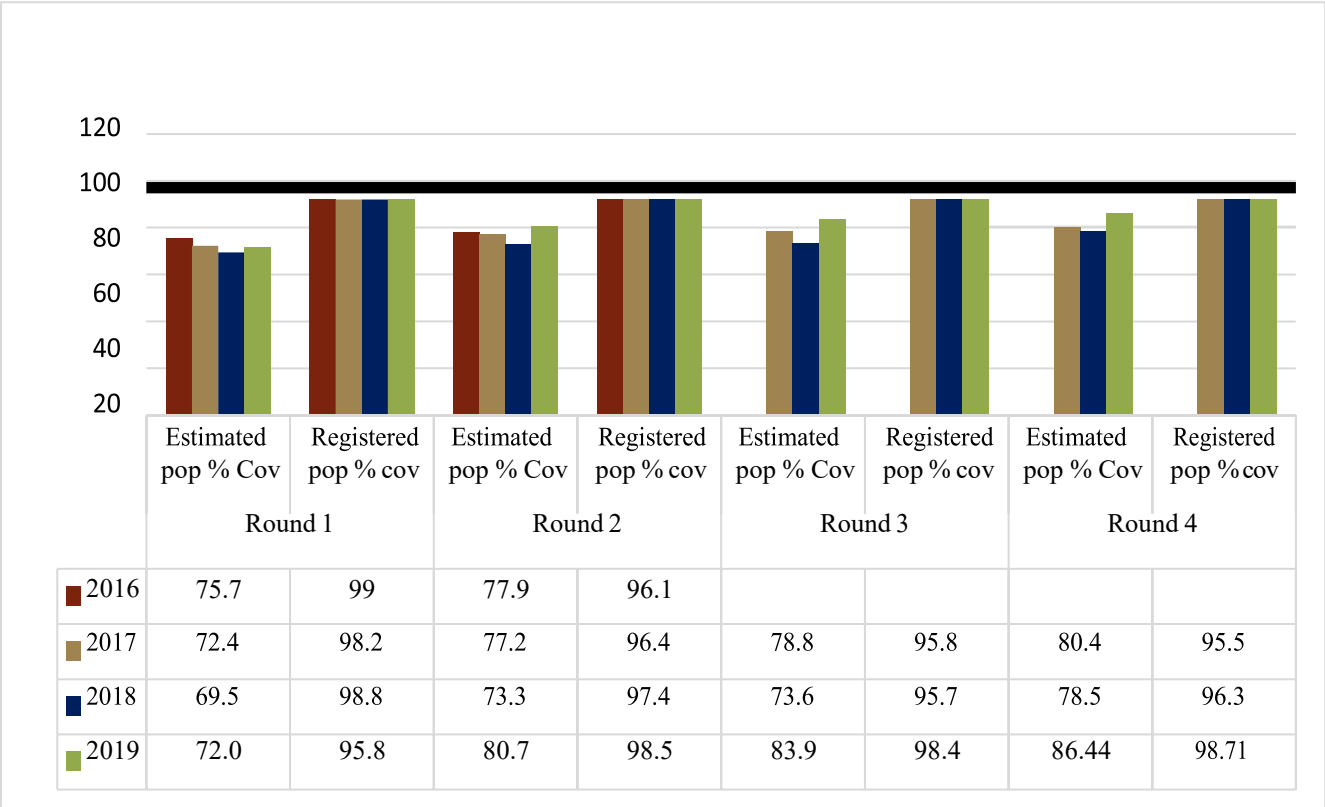
	Years			
District	**2016**	**2017**	**2018**	**2019**
Daffiama-Bussie-Issa	0.80	0.92	0.83	0.79
Jirapa	0.11	0.95	0.94	0.96
Lambussie	0.10	0.89	0.70	0.99
Lawra	0.09	0.99	0.99	0.99
Nadowli-Kaleo	0.05	0.94	0.59	0.93
Nandom	0.11	0.89	0.95	0.89
Sissala East	0.18	0.84	0.77	0.70
Sissala West	0.37	1.00	1.00	1.00
Wa Municipal	0.00	0.86	0.98	0.94
Wa East	0.11	0.82	0.70	0.69
Wa West	0.05	0.62	0.83	0.99
Total (Region)	1.97	9.72	8.75	9.87

Source: (GHS_UWR, 2020)

1.6.4.3 Use of Seasonal Malaria Chemoprevention (SMC)

The SMC is one of the malaria interventions undertaken by the Ghana Health Service in the region since 2015 (Chatio et al., 2019). SMC refers to the prevention of malaria according to distinct seasonal patterns. It is usually undertaken during the season with predominant malaria cases (i.e., the rainy/farming season in Ghana). The SMC program usually makes use of the service of Community-Based Health Volunteers who are then supervised by district and sub-district health

workers (Chatio et al., 2019). The peak of the malaria transmission period in the Upper West Region (Figure 1) occurs from June to September. The SMC campaign administers sulfadoxine-pyrimethamine (SP) and Amodiaquine (AQ) to children 3 to 59 months of age. A full dosed child is usually given four courses of treatment. (Chatio et al., 2019): on the first day, SP and AQ are given; on the second and third day, the child is given AQ. The main objective is to maintain therapeutic anti-malarial drug concentrations in the blood to prevent malaria illness during the most significant malarial risk to reduce under-five malaria-related morbidity and mortality (Chatio et al., 2019). The farming activities and frequent rains often distract the exercise, making volunteers dose mostly in the evenings. Inadequate transport for volunteers' supervision, and volunteer fatigue and complacency are often some observed challenges, especially by the third and fourth rounds. However, community members warmly received volunteers and allowed their children to be dosed, and some volunteer teams issued medicines to households in the absence of caregivers, thus achieving high coverage. The 'estimated population' refers to the presumed number of eligible children for the SMC before implementing the exercise, while the 'registered population' refers to the actual number of eligible children that have been covered in real-time during the SMC exercise (Figure 2).



	Round 1		Round 2		Round 3		Round 4	
	Estimated pop % Cov	Registered pop % cov	Estimated pop % Cov	Registered pop % cov	Estimated pop % Cov	Registered pop % cov	Estimated pop % Cov	Registered pop %cov
2016	75.7	99	77.9	96.1				
2017	72.4	98.2	77.2	96.4	78.8	95.8	80.4	95.5
2018	69.5	98.8	73.3	97.4	73.6	95.7	78.5	96.3
2019	72.0	95.8	80.7	98.5	83.9	98.4	86.44	98.71

Figure 2: Seasonal Malaria Chemoprevention Coverage in UWR 2016 - 2019

1.7 Study Objectives

Preamble to objectives: Among Ghanaian pregnant women, anaemia (haemoglobin <11.0 g/dL) in pregnancy was 56.0% in 2019, (Dosoo et al., 2020) and malaria accounted for 18.0–33.0% of overall outpatient hospital attendance, (Dosoo et al., 2020), 11–34.3% of overall hospital admissions (GHS-NMCP, 2020) and 9.0% of maternal deaths (Ghana Health Service, 2015). It is unclear if the generally poor uptake of IPTp-SP and ITN interventions in the country is due to lack of knowledge on both provider and recipient sides, insufficiency of the prevention tools and materials, or both.

Main objective

To investigate factors related to the uptake of IPTp and ITN malaria prevention measures among pregnant women in the Upper West Region of Ghana.

Specific objectives

1. To estimate the uptake of sulfadoxine-pyrimethamine (SP) and the usage of ITNs among pregnant women in urban and rural areas.
2. To determine the characteristics that influence the uptake of SP and the ITN usage among pregnant women.
3. To assess the knowledge of pregnant women on the risks of malaria in pregnancy.
4. To measure the ANC provider knowledge on the national SP policy.
5. To assess the dosage of folic acid prescribed to pregnant women.
6. To estimate the proportion of pregnant women in Ghana who are co-administered SP and the internationally recommended dosage folic acid.

2 MATERIALS & METHODS

2.1 Study Area

2.1.1 Upper West Region of Ghana

The Upper West Region (UWR) is situated in the north-western part of Ghana (Figure 3). Geographically, the region is located between longitude 1.25'' W and 2.45'' W and latitude 9.30'' N and 11.00'' N. It is bordered to the south by the Savannah Region, to the east by the Upper East Region and the north and west by the Republic of Burkina Faso (figure 3). The region's estimated population for 2020 currently stands at 868,484, with 49.2% males and 50.8% females (Ghana Statistical Service, 2013; Ghana Statistical Service, 2014; GHS_UWR, 2020). The region covers 18,476 km^2 with a population density of 33 - 40 persons per square kilometre (GHS_UWR, 2020; City Population.de, 2020b). A smaller proportion (16.3%) of the population in this region lives in urban areas than the 51% national figure (Ghana Statistical Service, 2014; Kuusaana & Eledi, 2015; Oteng-Ababio et al., 2019). Like in many other parts of Ghana, most of the people in the region are peasant farmers for both commercial and subsistence purposes, depending mainly on the rainfall for their farming activities. The people also engage in spinning, weaving, smock designing, and musical instruments such as the xylophone (Ghana Statistical Service, 2013). The region has eleven administrative districts, out of which four are municipalities, and the remaining are rural districts (GHS_UWR, 2017).

2.1.2 Brief Profiles of selected Districts of Study

This study considered two of the eleven districts as indicated in Figure 3, both of which are respectively further described.

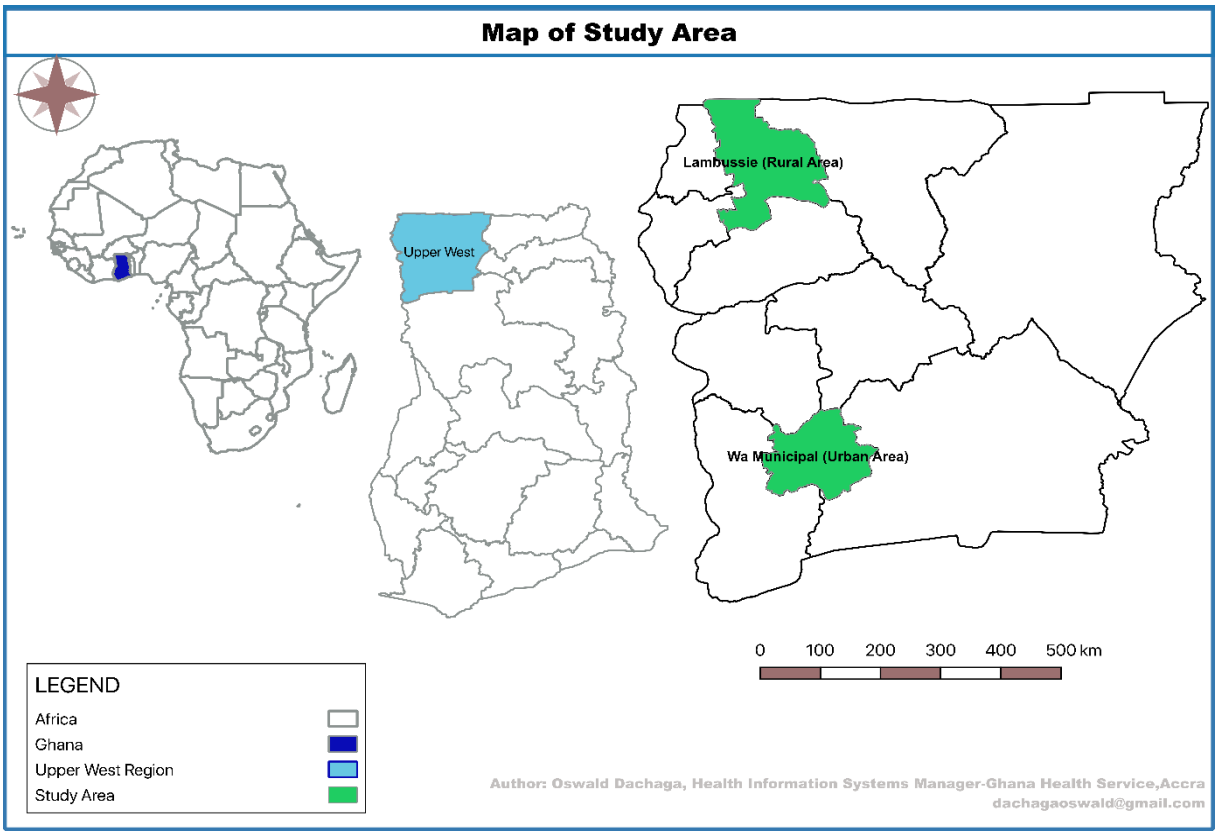


Figure 3: Map of the study area (Upper West Region), showing the two districts selected.

2.1.2a The Wa Municipality (urban area)

Wa Municipal is one of the 260 Metropolitan, Municipal and District Assemblies (MMDAs) in Ghana. It is among the eleven Municipalities and districts in the region of Upper West. It occupies a landmass of about 1,078km², which lies between latitudes 9º 55" N and 10º 25" N and longitude 1º 10" W and 2º 5" W. It has a population of 132,646 (66,376 males and 66,270 females), a literacy rate of 68% and 66% urban residence (Ministry of Local Government, 2020; City Population.de, 2020c; Ghana Statistical Service, 2013; Oteng-Ababio et al., 2019) (Figure 3).

2.1.2b The Lambussie District (rural district)

The Lambussie District was the rural district considered under this study. The current estimated population of the district stands at 63,889 with 31,252 (51.1%) males and 32,637 (48.9%) females with a population density of 77.90/km² (City Population.de, 2020a; Ministry of Local Government, 2020; Ghana Statistical Service, 2013). In 2010, about 63% of the population was illiterate, with about 87% rural residence (Ghana Statistical Service, 2013) (Figure 3).

2.2 Health Service Structure in the Upper West Region

The eleven Budget Management Centres administratively manage the health system in the region with the District Health Management Teams (DHMTs) respective districts. The DHMTs are supervised by the Regional Health Management Team (RHMT). For effective health service delivery purposes, each district is further divided into health sub-districts. There are seventy-two sub-districts administratively managed by Sub-district Health Teams (SDHTs) (GHS_UWR, 2020). Each sub-district is divided into Community Health Planning and Service (CHPS) zones to ensure community health service delivery. There are four hundred and forty-eight health facilities providing various types of services in the region. The region has one regional hospital, eight district hospitals and three private hospitals. The rests are four polyclinics, seventy-two health centres, fifteen clinics, three hundred and twenty-five CHPS compounds and four maternity homes (Table 3). Three out of the eleven districts in the region (DBI, Wa East, and Lambussie) have no district or private hospital (GHS_UWR, 2020) (Table 3).

Table 3: Distribution of Health Facilities by Type, December 2019

DISTRICTS	CHPS	Clinic	Health Centre	Hospital	Maternity Home	Polyclinic	Private	Regional Hospital	Teaching	University	Total	Sub-District
DBI	16	0	5	0	0	0	0	0	0	0	21	5
Jirapa	37	1	7	1	0	1	0	0	0	0	47	8
Lambussie	27	2	5	0	1	1	2	0	0	0	38	6
Lawra	23	1	5	1	0	1	0	0	0	0	31	5
Nadowli-Kaleo	26	0	10	2	0	0	0	0	0	0	38	8
Nandom	24	0	4	1	1	1	1	0	0	0	32	5
Sissala East	52	1	8	1	1	0	3	0	0	0	67	7
Sissala West	29	0	6	1	0	0	0	0	0	0	36	5
Wa East	29	1	9	0	0	0	1	0	0	0	40	7
Wa Municipal	28	8	7	4	1	0	5	1	0	0	54	10
Wa West	34	1	6	1	1	0	1	0	0	0	44	6
Total	325	15	72	12	5	4	13	1	0	0	448	72

Source: **(GHS_UWR, 2020)**

2.2.1 Human Resource Capacity

The region has 375 community health officers (CHOs) providing various services in the health facilities as of December 2019 (GHS_UWR, 2020). Additionally, there are other technical staff who complement the efforts of CHOs in the provision of service delivery at the community level. They include the Enrolled Nurses (EN - 179), Midwives (MW - 68); and Community Health Nurses (CHN - 101). When compared to the number of functioning zones, the number of staff shows an average of two in each CHPS zone (GHS_UWR, 2020). The technical staff are those officially trained, certified, and formally employed as Ghana Health Service staff by the Ministry of Health. The volunteer staff refer to the caucus of indigenes of various communities. They are usually identified by the health authorities with the help of community members and given orientation to temporarily assist the technical staff in making health service more accessible to the people (Table 4).

Table 4: Human Resource and Volunteer Support in CHPS zones

	TECHNICAL STAFF							VOLUNTEERING SYSTEM				
DISTRICT	**No. of functional CHPS Zones**	**No. of CHOs**	**No. of CHN**	**No. of EN**	**No. of MW**	**No. of Other health staff**	**Total**	**Average numb of Staff Per Zone**	**No. of active CHMC**	**No. of active CHV**	**No of functional CHPS zone with CHAP**	**Total**
DBI	18	26	10	8	5	0	49	3	26	74	26	126
Jirapa	37	53	7	19	3	0	82	2	37	198	37	272
Lambussie	29	28	11	9	7	0	55	2	28	179	24	231
Lawra	23	35	10	10	3	0	58	3	21	164	29	214
Nadowli	33	36	10	13	8	0	67	2	33	174	32	239
Nandom	37	32	5	24	3	2	66	2	37	148	30	215
Sisala East	38	40	20	26	3	1	90	2	45	144	37	226
Sisala West	32	34	0	13	0	0	47	1	32	124	20	176
Wa East	30	30	16	21	3	1	71	2	30	127	30	187
Wa Mun	28	28	5	14	15	1	63	2	28	120	28	176
Wa West	31	33	7	22	13	0	75	2	31	250	31	312
Region	**336**	**375**	**101**	**179**	**63**	**5**	**723**	**2**	**348**	**1702**	**324**	**2374**

Source: (GHS_UWR, 2020)

2.2.2 Maternal Health Indicators of the Study Area

In 2019, the region recorded an ANC coverage of 82% (27,784) compared to the national target of 90%, indicating that there is much work to be done (Figure 4). ANC coverage (≥ 4 visits) is the percentage of women aged 15–49 with a *live birth* in a given period that received four or more *antenatal care* services during their pregnancy, attended by any provider (MDG Wiki Handbook, 2012). Intensive health education as well as documentation improvement are some measures needed in achieving this indicator (GHS_UWR, 2020).

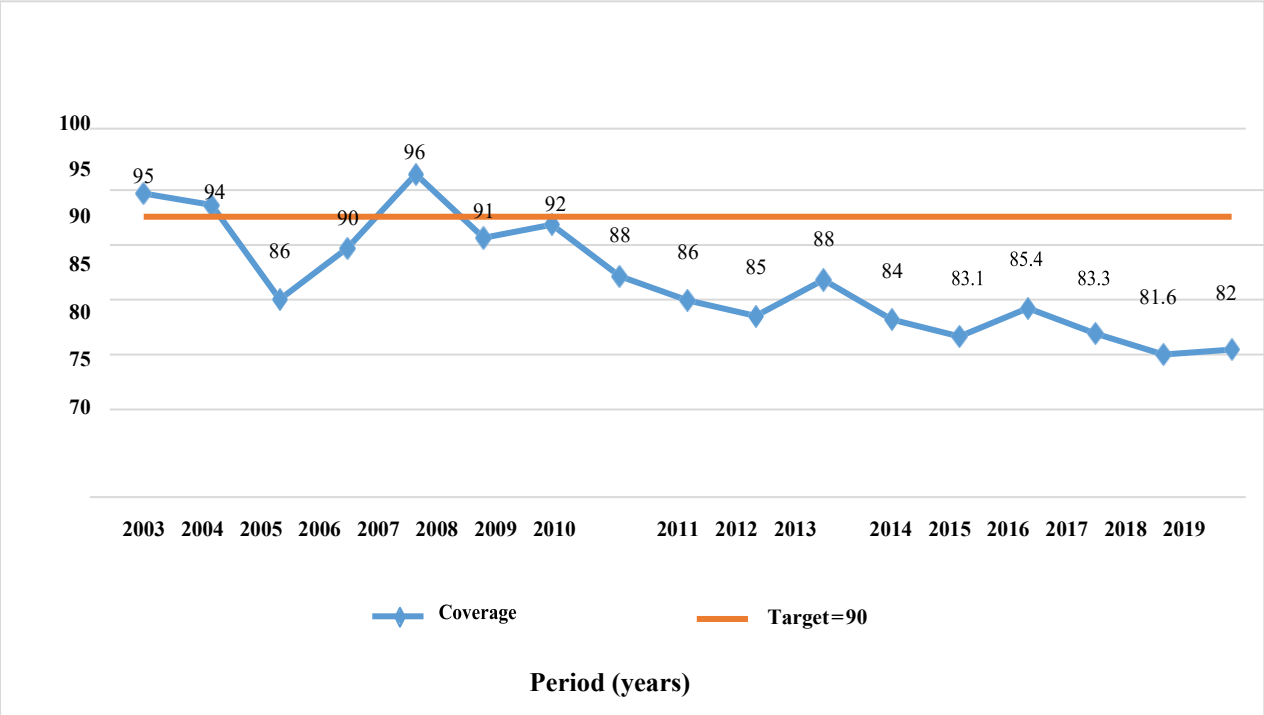


Figure 4: Annual Trend of Antenatal Coverage 2003 - 2019 in UWR

Source: **(GHS_UWR, 2020)**

The proportion of pregnant women who registered at ANC within their first trimester of pregnancy in the region rose from 62.9% in 2018 to 67.2% in 2019 but still far below the national target of 90% (Figure 5) (GHS_UWR, 2020).

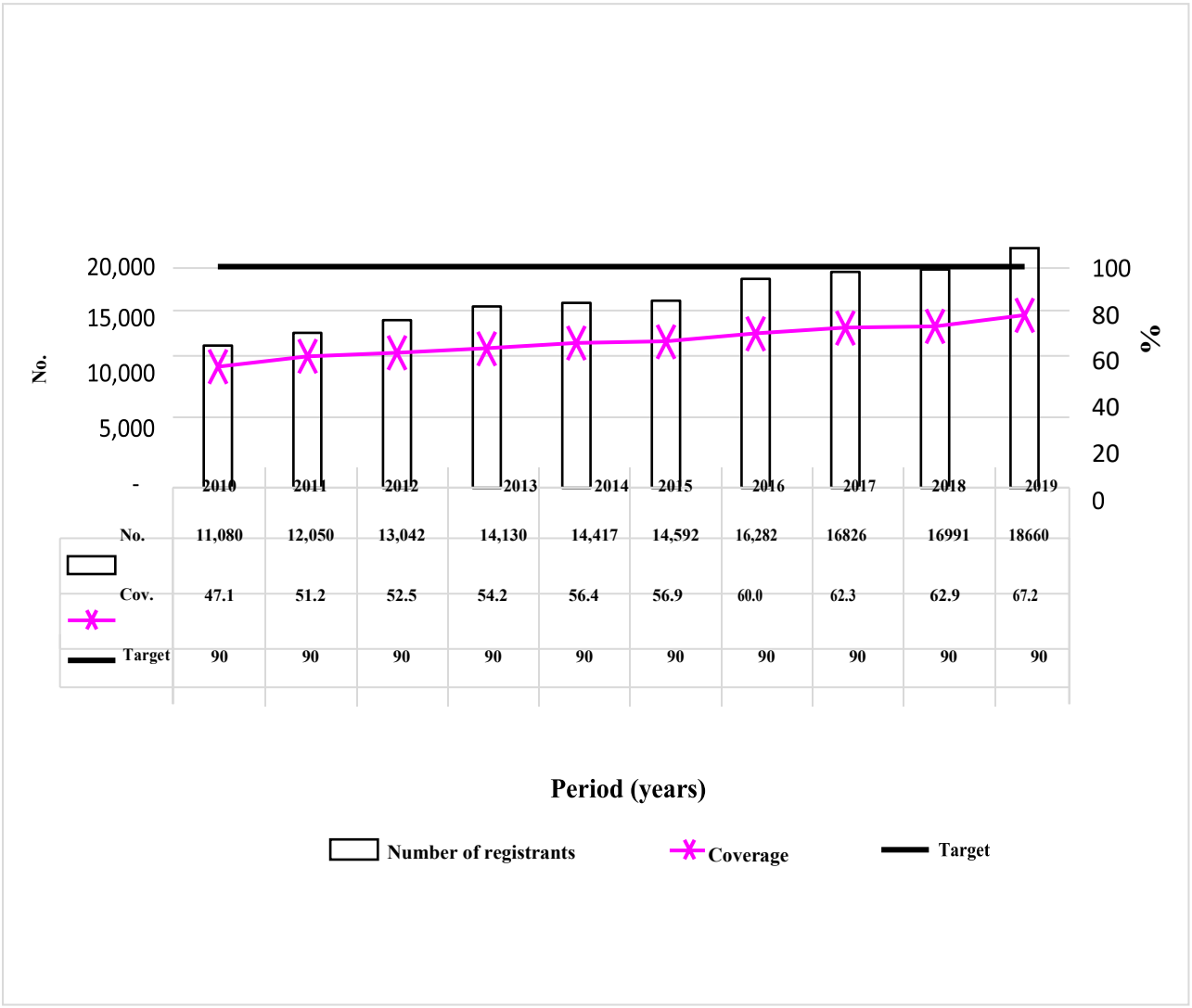


Figure 5: Percentage of Antenatal Mothers registered in 1st Trimester in UWR from 2010 – 2019.

Source: (GHS_UWR, 2020)

The national reproductive health policy recommends that every pregnant woman should make a minimum of four ANC visits before delivery. Even though the WHO has adjusted the minimum number of visits to eight, pregnant women are still not achieving the initial recommendation of four visits. About 73% and 81% of the pregnant women in the Wa Municipality (urban) and the Lambussie district made at least four ANC attendance in 2019. The performance of ANC attendance across the various districts in the study region are presented in Table 5 (GHS_UWR, 2020).

Table 5: District-based proportions of at least four ANC visits by District/Municipal 2019

District	DBI	Jirapa	Lambussie	Lawra	Nadowli	Nandom	Sissala East	Sissala West	Wa East	Wa Mun.	Wa West	Total
Absolute numbers	987	2,566	1,203	1,204	2,619	1,057	2,247	1,488	2,151	4,883	2,469	22,874
% of visits	88.4	105.4	81.4	77.6	112.5	79.8	77.1	73.3	71.9	73.3	83.7	82.3

Source: (GHS_UWR, 2020)

Out of the total number of ANC registrants for 2019, the prevalence of anaemia is about 30% in the study region, 36% in the Wa Municipality (urban) and 22% in the Lambussie District (rural) (Table 6), with 9.3% record of low birth weight (LBW) (Figure 6).

Table 6: Anaemia Check at ANC Registration by District/Municipal - 2019 Performance

Indicator	DBI	Jirapa	Lambussie	Lawra	Nadowli	Nandom	Sissala East	Sissala West	Wa East	Wa Mun.	Wa West	Total
Totals	1113	2433	1480	1551	2332	1326	2160	2029	2987	6667	2957	27035
Haemoglobin < 11g/dl	108	713	330	701	639	655	726	706	908	2,380	556	8,422
% anaemic (Hb< 11g/dl)	9.7	29.3	22.3	45.2	27.4	49.4	24.9	34.8	30.4	35.7	18.8	31.2

Source: (GHS_UWR, 2020)

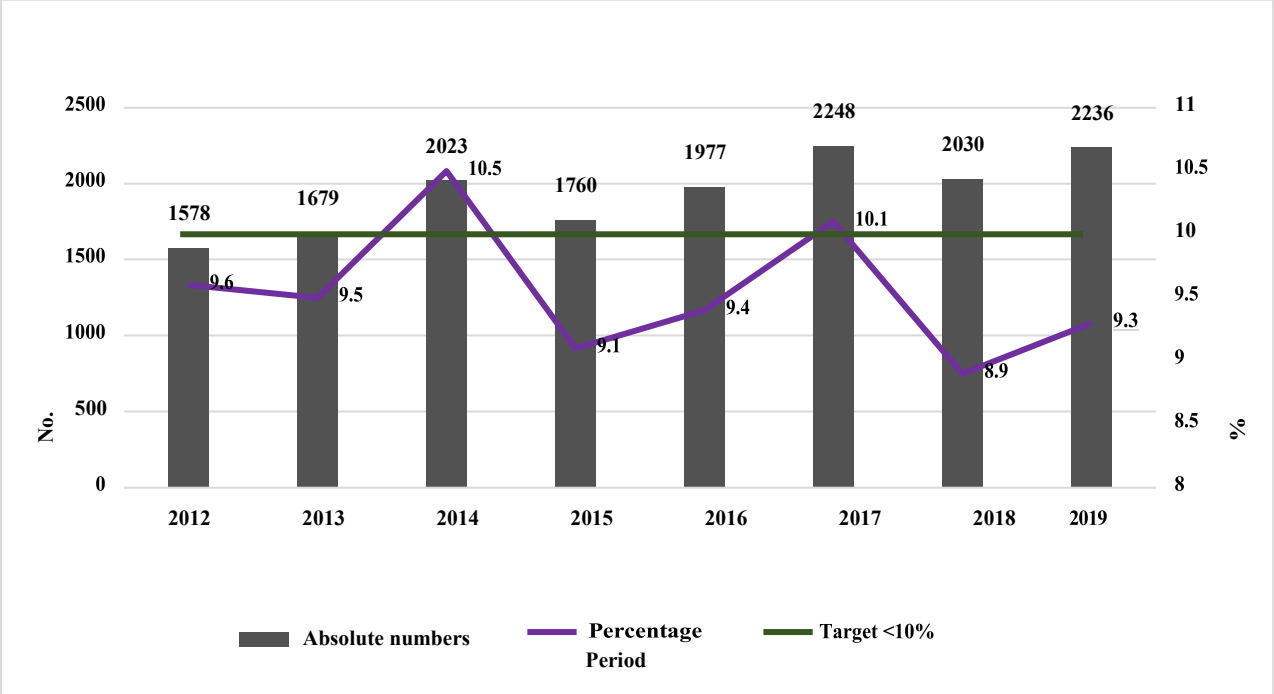


Figure 6: Trend of Proportion of Low Birth Weight in UWR from 2012 - 2019

2.3 Study Design

The sequential explanatory mixed-method model of a quantitative-qualitative design was adopted with a multi-stage sampling technique (Ishtiaq, 2019b). The study was conducted among third trimester pregnant women in two of the eleven administrative districts of the Upper

West Region of Ghana: one urban (Wa Municipal) and one rural (Lambussie District). The study was conducted in 37 primary health care (PHC) facilities with antenatal care services in the Upper West Region of Ghana, administered through the Ghana Health Service (GHS) under the Ministry of Health (MoH). The fieldwork covered the period between November 2018 to May 2019 concurrently in the selected urban and rural districts. The study assessed the the uptake of IPTp-SP and of ITN usage in the pregnant women selected. The framework of the study, the number of study participants selected, and the methods used are detailed in figures 7 and 8 for IPTp-SP and the ITNs intervention, respectively.

2.4 QUANTITATIVE STUDY

2.4.1 Survey of Pregnant Women

This study's population comprised pregnant women who attended and received ANC services at the 37 primary health care facilities selected for this study. Specific to the respective study districts, the sample frame included all 7,968 pregnant women - 6,491 in Wa Municipal and 1,477 in Lambussie district who registered and attended ANC in the previous year (2018). Within the data collection period, any pregnant woman found at the selected study facilities' antenatal care clinics and who met the inclusion criteria (figures 7&8) was recruited.

2.4.2 Sample Size and Sampling

The study had two sample sizes for the IPTp-SP and ITNs interventions, respectively: these were calculated independently based on the available assumptions and parameters appropriate to each intervention.

2.4.3 Sample Size I: *IPTp-SP Intervention*

Given the current information on the proportions of SP uptake in the urban and rural districts (26.1 % and 17.6 %, respectively) (WMHD_GHS, 2017), the municipal and district areas' sample size was estimated with a two-sample proportions test. A sample size of 740 pregnant women (i.e. 370 for each district) was arrived at, assuming 80% power and 5% alpha (Wang,

2000).

2.4.4 Sample Size II: *ITNs Intervention*

The feature of a two-sample comparison of proportions in Stata Software (version 14.2) was used to determine a representative sample size for a comparative assessment of this intervention. According to unpublished data from the regional health directorate, the estimated prevalence of ITN use among pregnant women in the study region was 70% for rural and 60% for urban areas. These estimates were entered into the Stata software, assuming a sample power of 80%, an alpha effect of 0.05 (two-sided t-test), and a sample ratio of 1. Thus, a sample size (N_1) of 355 was realized for urban and rural districts apiece. Therefore, the data on ownership and use of ITNs were collected from a total sample size (N) of 710 3rd trimester pregnant women.

2.4.5 Selection of study districts and health facilities

A multiple sampling approach was used (Ishtiaq, 2019a; Creswell & Clark, 2007). Two of eleven (4 urban and 7 rural) administrative districts in the region – one urban (purposive) and one rural (simple random) - were selected for comparison (Oduro et al., 2010; Ibrahim et al., 2017; Addai-Mensah et al., 2018; Oppong et al., 2019). There are 27 ANC facilities in the rural district of Lambussie and 27 in the urban district of Wa Municipality (Table 7). Due to logistical constraints, we could not cover all facilities. Through simple random sampling, we selected 20/27 health facilities (HFs) in Lambussie and 17/27 HFs in Wa Municipality – a total of 37/54 HFs for both districts. Due to time and logistical constraints, we could not access enough research assistants for each district to cover an equal proportion of HFs. Presented below (Table 7) are the details of the health facilities selected in each district.

Table 7: Distribution of Study Districts, Sub-Districts, HFs & ANC Staffs Selected

Country: **Ghana** Region: **UWR**	**Districts selected**	**Sub-Districts selected**	**ANC HFs available**	**ANC HFs selected**	**ANC Staffs at post**	**ANC Staffs selected**
Ghana/Upper Wes Region	Wa Municipal (Urban)	Bamahu	7	4	Specifics could not be accessed but ranged from 1 to 5 each	8
		Busa	3	2		4
		Charia	2	1		2
		Wa North	6	4		8
		Wa South	5	3		6
		Kambali	4	3		6
		Sub-total	*27*	*17*		*34*
	Lambussie District (Rural)	Billaw	5	3		6
		Hamile	7	5		10
		Karne	4	3		6
		Lambussie Main	1	1		2
		Piina	3	3		6
		Samoa	7	5		10
		Sub-total	*27*	*20*	111*	*40*
Total	**2/11**	**12/16**	**54**	**37**		**74**
"*" *means specifics to sub-districts not accessible*						

Source: Fieldwork (2019)

Table 8 presents the respective **quota** of pregnant women sampled per facility for IPTp-SP and ITNs, respectively. In contrast, Table 9 presents the list of selected health facilities.

Table 8: Proportions of Pregnant Women Recruited at HFs from the 2 Districts, for IPTp-SP and ITNs

District	Year	Sub-District	ANC population (A)	Percentage of total ANC (B)	Sample size quota (Q) = {(B/100) ×A)}	
					IPTp-SP	ITNs/LLINs
WA MUNICIPALITY	2018	Bamahu Sub	549	10.4	38	37
		Busa Sub	290	5.5	20	19
		Charia Sub	175	3.4	13	12
		Wa North Sub	861	16.3	60	58
		Wa South Sub	2446	46.4	172	165
		Kambali Sub	949	18.0	67	64
		***Sub-total* (N1)**	***5,270***	***100.0***	***370***	***355***
LAMBUSSIE						
		Billaw Sub	187	12.7	47	45
		Hamile Sub	475	32.3	119	114
		Karni Sub	235	16.0	59	57
		Lambussie Sub	120	8.1	30	29
		Piina Sub	169	11.5	43	41
		Samoa Sub	286	19.4	72	69
		***Sub-total* (N2)**	***1,472***	***100.0***	***370***	***355***
		Total (N)	**7,968**	**100**	**740**	**710**

Source: Fieldwork (2019)

Note:

1. **%B:** Refers to the percentage of the sub-total ANC population (N1 or N2) a particular sub-district constitutes.
2. **Demonstration**: for **Bamahu-Sub**, research assistants sampled 37 of the 549 registered pregnant women, computed as follows: {(A/N1) ×100} = B%. Thus, {(549/5270) ×100} = 10.4%. Thus, 10.4% of 549 = 37.
3. **Total (N) =** N1+N2.

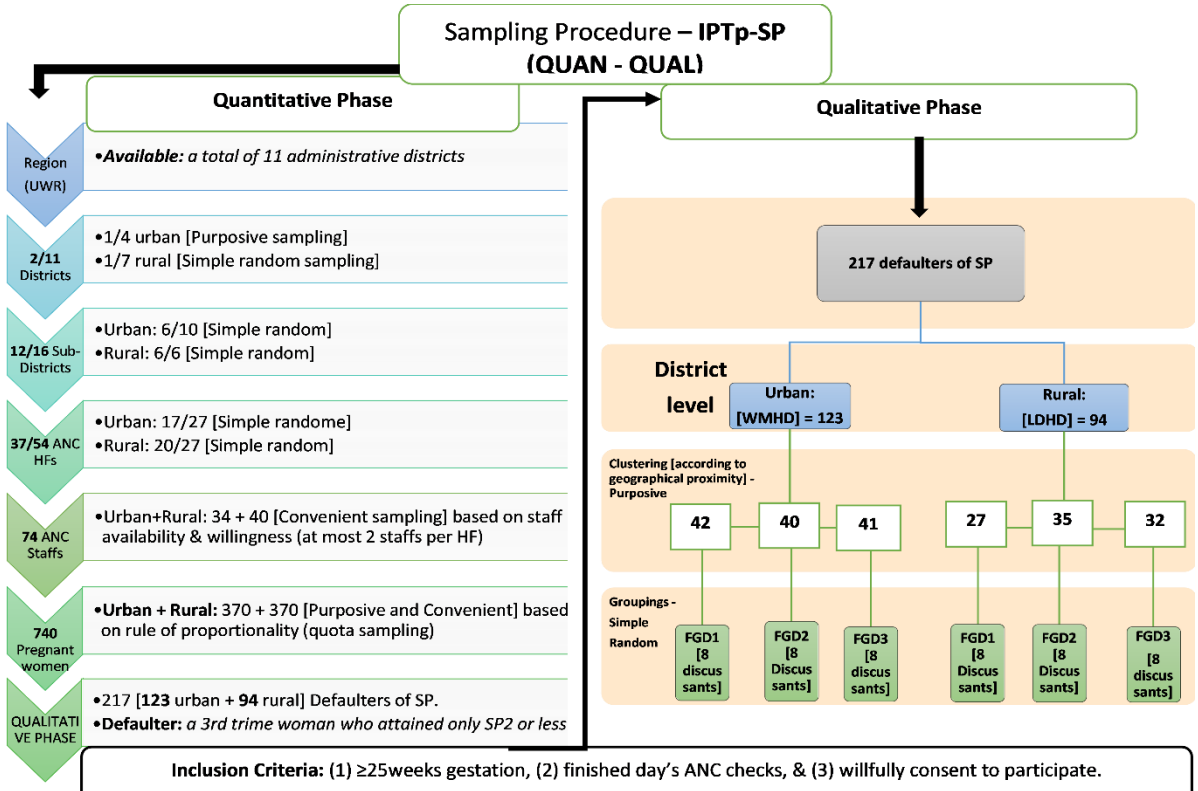
Table 9: Sub-Districts and Health Facilities selected

Health facilities selected		
District	**Sub-District**	**HFs Selected**
Wa Municipal - Urban	BAMAHU SUB	Bamahu HC
		Danko CHPS
		Piisi CHPS
		UDS Hospital
	BUSA SUB	Busa HC
		Jonga CHPS
	CHARIA SUB	Charia HC
	WA NORTH SUB	Market Clinic
		Adolescent HC
		Fongu CHPS
		Kumbiehi CHPS
	WA SOUTH SUB	Wa Urban HC
		Sokpayiri CHPS
		Konta CHPS
	KAMBALI SUB	Kambali HC
		Mangu CHPS
		Nakori CHPS
Lambussie-Karni	BILLAW SUB	Billaw HC
		Chebogo CHPS
		Hinenteng CHPS
	HAMILE SUB	Hamile HC
		Muslim clinic
		Kanyiri Maternity Home
		Chetu CHPS
		Bamwon CHPS
	KARNI SUB	Karni HC
		Kpare CHPS
		Happa CHPS
	LAMBUSSIE SUB	Lambussie Polyclinic
	PIINA SUB	Piina HC
		Sentu CHPS
		Hacha CHPS
	SAMOA SUB	Samoa HC
		Naawie CHPS
		Suke CHPS
		Chognuor CHPS
		Koro CHPS

Source: Fieldwork (2019)

2.4.5 Sampling Procedure

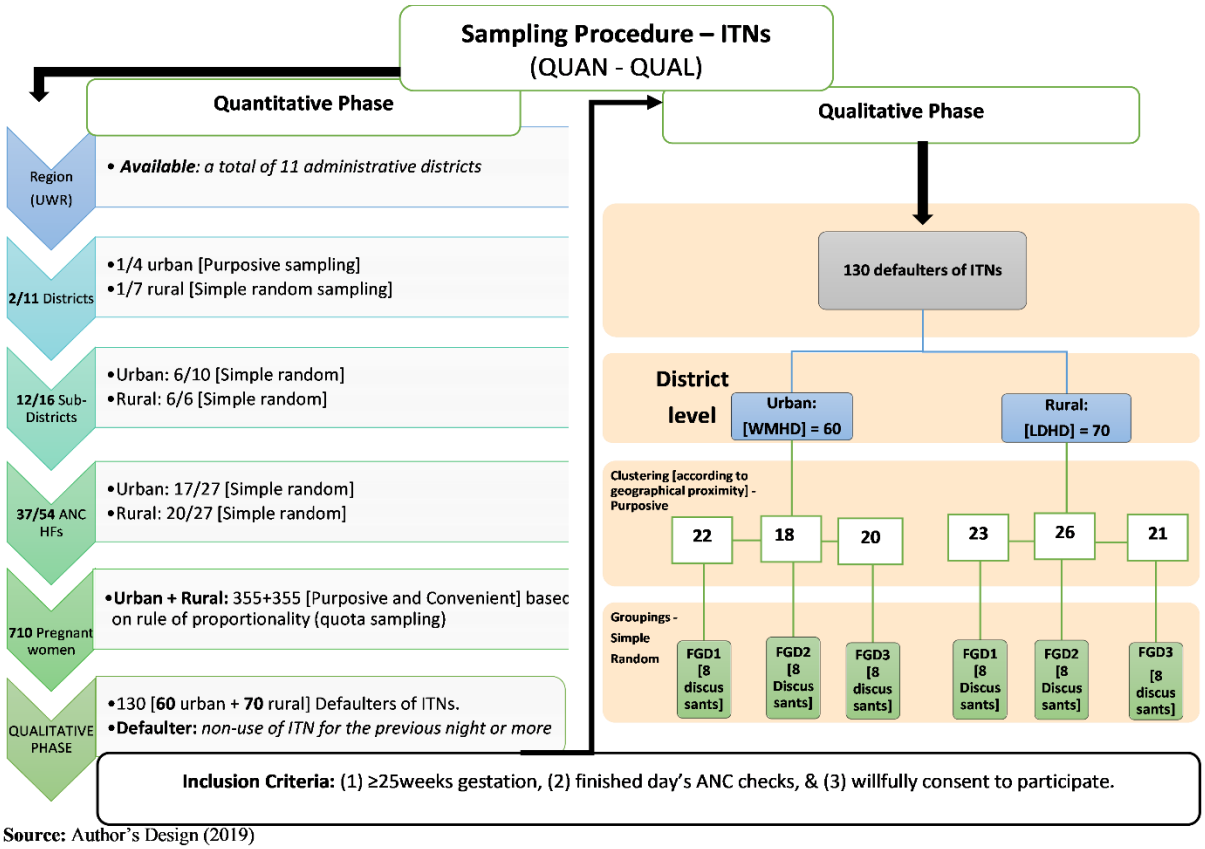
As presented in figures 7 and 8, the sampling procedure was a multi-stage approach. It was carried out in phases for both interventions, as described below. Pregnant women were recruited from the health facilities during their routine ANC visits through a mix of consecutive and purposive sampling. The purposive phase was based on considering that the study selected pregnant women in their third trimester (≥25weeks gestation).



Source: Author's Design (2019)

Figure 7: Study design and sampling procedure for IPTp-SP

The following figure (8) presents the sampling procedure. This study assessed the ownership and usage of insecticide-treated bed nets among pregnant women.



Source: Author's Design (2019)

Figure 8: Study design and sampling procedure for ITNs ownership and usage

Both sampling procedures (Figures 7 & 8) were executed concurrently using the same sample size for the IPTp-SP intervention because:

1. The study was designed and granted ethical clearance as a one-time study and needed to be conducted within the same period, thus it could not have been executed at separate times.
2. The estimated sample size for the IPTp-SP intervention is greater than that of the ITNs intervention. Since time was limited and the access to pregnant women at the facilities was challenging, it was easier and economical to combine and administer the ITNs questionnaire and questions assessing IPTp-SP as a single data collection instrument for the quantitative and qualitative phases.

3. For easy monitoring of the data collection process to ensure data quality, each data collection assistant was assigned to a specific number of health facilities in a designated zone within the same period.
4. The recruitments of participants for both IPTp-SP and ITNs were done at the same selected health facilities across both urban and rural districts.

2.4.6 Sampling Technique

Generally, the study used the Consecutive Sampling method to enlist the respondents into the study: every pregnant woman who was met at any of the 37 ANC facilities (Table 9) during the study period who met the inclusion criteria was enrolled. The process was maintained until the required sample size for each intervention in each district was obtained.

2.4.7 Eligibility Criteria

2.4.7.1 Inclusion Criteria

To be qualified for recruitment into the study, a pregnant woman needed to have met the following criteria: (1) gestational age ≥ 25 weeks, (2) completion of routine ANC on the day of the interview, and (3) informed written or thumb-printed consent.

2.4.7.2 Exclusion Criteria

Any pregnant women who did not meet the inclusion criteria were not enlisted into this study.

2.4.8 Data Collection Instruments and Procedures

2.4.8.1 Data Collection Instruments

The quantitative data were collected using questionnaires through semi-structured interviews and a review of respondents' ANC records.

2.4.8.2 Survey of ANC nurses

The study recruited and administered a questionnaire on 74 nurses and midwives at their respective health facilities where the pregnant women were interviewed. The nurses were

chosen by convenience sampling from the 17 urban HFs (n_1=34) and 20 rural HFs (n_2=40) (Table 9). To avoid the possibility of nurses referring to literature or conferring with colleagues to answer the questions, they could not self-administer the questionnaire. Data on professional characteristics of 74 nurses were collected through quantitative means of questionnaire administration. In addition, open questions related to the health system-related challenges in implementing the IPTp-SP policy and how they manage them were asked. Nurses and midwives were interviewed by trained research assistants using a semi-structured questionnaire. Twelve Clinical and Community Health Nurses (5 in the urban and 7 in the rural study area) were trained to administer the questionnaires.

2.4.9 Study Variables

From Table 10, the dependent outcome variables collected on pregnant women included the uptake of IPTp-SP measured as count variable, the co-administration of SP and folic acid also measured as count, and usage of ITNs measured as a categorical variable. The following were also considered as the explanatory variables and measured as categorical: marital status, occupation, educational attainment, marital category, ownership of an ITN, and maternal knowledge of malaria in pregnancy. Meanwhile, maternal age, average monthly income, gestational age at first ANC, gestational age at interview, parity, household size, and the number of ANC visits were measured as count variables.

Table 10: Study Variables and Measurements

Respondents	VARIABLE	MEASUREMENT of Variable
Pregnant Women	**Independent/Explanatory Variables**	
	Maternal age (years)	Continuous
	Marital status	Categorical variable: Married, Single, Co-habiting
	Occupation	Categorical: Farming, Public servant, Private/petty business, Unemployed
	Formal Education	Categorical: None, Basic school, Secondary, Tertiary
	Average monthly income	Continuous
	Gestation	Continuous (in weeks)
	Gestational age at 1st ANC	Continuous (in weeks)
	Gravidity	Continuous (in number of weeks)
	Parity (No. of own children alive)	Discrete
	Household size	Discrete
	Marital category/family type	Categorical: Monogamous or Polygamous
	Knowledge of MiP	Categorical: Good knowledge or poor knowledge
	ANC visits	Discrete
	Ownership of an ITN/LLIN	Categorical: Yes/No
	Dependent/Outcome variables	
	Uptake of SP doses	Count of SP doses taken: Discrete
	Usage of ITNs/LLINs	Categorical: Yes/No
	Combined SP & folic acid	Categorical: Yes/No
ANC Service Providers	Profession by training	Categorical: Midwife, CHN/EN, Other
	Years of experience on current role	Continuous (in years)
	IST/workshop on midwifery	Categorical: Yes/No
	Knowledge of IPTp-SP policy	Categorical: Good or Poor
	Distance to nearest referral facility	Continuous (in kilometers)
	Availability of SP for IPTp	Open-ended questions
NB: "MiP" means malaria in pregnancy, IST: In-Service Training		

Source: Fieldwork (2019)

2.4.10 Quantitative Data Analyses

Quantitative data were compiled and cleaned using SPSS version 20 and analyzed using Stata software (version 14.0). In 5.8 % (43/740) of the interviewed women, data on the outcome of the study were missing and therefore not considered for analyses. First, socio-demographic, obstetric and gynaecological characteristics of pregnant women were described. Second, Poisson regression was used to analyze determinants of SP uptake (number of taken SP doses) by estimating adjusted incidence rate ratios (IRR). Out of the 74 ANC service providers from whom data were collected, 64 (n_1+n_2=28+36) were used for the data analysis after data cleaning. Ten of the interviewed staff were not included in the analysis because of missing or incomplete information regarding their professional background. Binary logistic regression analysis was used to analyze the determinants of ITN usage among pregnant women.

2.5 QUALITATIVE STUDY

2.5.1 Focus Group Discussions with Pregnant Women

Focus group discussions (FGDs) were organized according to standard recommendations (Morgan, 1996; Kruger & Casey, 2000) and conducted with defaulters. For this study, a defaulter of the SP intervention was defined as third-trimester pregnant women who had only reached SP2 or less. Similarly, an ITN defaulter was any third-trimester pregnant woman who had not slept under an ITN the previous day or two. A total of 217 IPTp-SP defaulters and 178 ITN defaulters, were identified. Three FGDs each were conducted in urban and rural study districts, respectively. Clusters of defaulters were built based on their residential proximity to their health facility. From the clusters, participants were randomly chosen ("hat picking") to form the focus groups. Eight adult pregnant women above age 18 participated in each of the FGDs for IPTp-SP and ITNs (figures 7 & 8). The FGDs were conducted in the local languages (Dagaare/Waale).

2.5.2 Qualitative Data Collection Instruments

The qualitative data were collected using a focus group guide, an audio recorder, and note pads (Eeuwijk & Angehrn, 2017). The focus group guide contained three main themes: (1) participants' basic understanding of malaria and pregnancy; (2) the challenges they encounter in accessing the IPTp-SP and using the ITNs interventions; and (3) if they had any suggestion to improve the IPTp-SP and ITNs intervention. The data collection tools were pre-tested on a group of selected defaulters for SP and ITNs in the Wa-Dobile community, an area that was not part of this study.

2.5.3 Qualitative Data Analyses

Qualitative data for both IPTp-SP and ITNs were analyzed independently using Microsoft Excel and QDA Miner Lite. Recorded discussions were transcribed into English, and then content analysis was performed: transcripts were coded manually, applying a mix of deductive and inductive coding, applying predefined themes from the questionnaire, and creating new codes as emerging from the transcripts. Synthesis of themes/codes was performed into phrase-clouds and presented as figures.

2.6 Ethical Aspects

Ethical approval was obtained from the Ethics Commission of the Medical Faculty of the Heidelberg University Hospital in Germany (S-775/2019) and the Ghana Health Service through the Navrongo Health Research Center (NHRC) in Ghana (CHRCIRB312). The questionnaires were reviewed and validated by the Navrongo Health Research Center in Ghana and the Research & Training Department of the Upper West Regional branch of the Ghana Health Service before the field visit permit was obtained. All study participants provided written informed consent.

3 RESULTS

This section is structured into two major parts – the quantitative and the qualitative components. The quantitative part contains descriptive and analytical results of both IPTp-SP and ITN interventions, beginning with the sociodemographic characteristics of the respondents, their obstetric and gynaecological characteristics, their knowledge of the risks of malaria in pregnancy, the Poisson regression on the uptake of IPTp-SP, and the Binary logistic regression on the usage of ITNs. The qualitative part consists of descriptive results from the focus group discussions held with selected defaulters of the IPTp-SP and ITN interventions. Even though the sample sizes for IPTp-SP and ITNs are different (chapter 2), the quantitative data on the sociodemographic and gynaecological information, as well as the knowledge characteristics of the pregnant women, are presented together.

3.1 QUANTITATIVE RESULTS

3.1.1 Descriptive Findings

3.1.1.1 Socio-demographic characteristics of pregnant women

Table 11 presents the socio-demographic characteristics of the interviewed pregnant women. The mean age was 27 (range 15-45) years. Most women were married, lived in households with 4-6 persons and worked as petty traders. About 90% of pregnant women reported having their own ITN, while 78% reported using it; there were no significant differences between the rural and urban study areas.

Table 11: Socio-demographic characteristics of pregnant women

	Full sample		Urban		Rural	
Variable	N	%	N	%	N	%
Age groups (in years)						
15-20	85	12.2	36	10.2	49	14.2
21-25	230	33.0	123	34.8	107	31.1
26-30	188	27.0	107	30.3	81	23.5
31-35	143	20.5	66	18.7	77	22.4
36-40	28	4.0	17	4.8	11	3.2
41-45	23	3.3	4	1.1	19	5.5
Occupational status						
Farming	79	11.3	7	2	72	20.9
Public Service	50	7.2	35	9.9	15	4.4
Petty trading	442	63.4	225	63.7	217	63.1
Unemployed	126	18.1	86	24.4	40	11.6
Marital Status						
Married	648	93	340	96.3	308	89.5
Single	49	7.0	13	3.7	36	10.5
Religious Affiliation						
Muslim	453	65.0	271	76.8	182	52.9
Christian	222	31.8	82	23.2	140	40.7
ATR*	22	3.2	0	0.0	22	6.4
Family Category						
Polygamy	195	28.0	80	22.6	115	33.4
Monogamy	453	65.0	260	73.7	193	56.1
Not Married	49	7.0	13	3.7	36	10.5
Level of formal education						
Primary/ none	251	36.0	107	30.3	144	41.9
Junior High	82	11.8	54	15.3	28	8.1
Senior High	238	34.1	120	34.0	118	34.3
Tertiary	126	18.1	72	20.3	54	15.7
Household Size						
1 - 3 persons	281	40.3	149	42.2	132	38.4
4 - 6 persons	303	43.5	147	41.6	156	45.3
≥ 6 persons	113	16.2	57	16.2	56	16.3
Total	**697**	**100.0**	**353**	**100.0**	**344**	**100.0**
Own ITN						
No	73	11.0	44	13.0	29	8.9
Yes	591	89.0	295	87.0	296	91.1
Use of ITN*						
No	130	22.0	60	20.4	70	23.7
Yes	461	78.0	235	79.6	226	76.3
Total	**664**	**100.0**	**339**	**100.0**	**325**	**100.0**

ATR*: *African Traditional Religion*| *Use of ITN*: captures only those who owned ITNs*

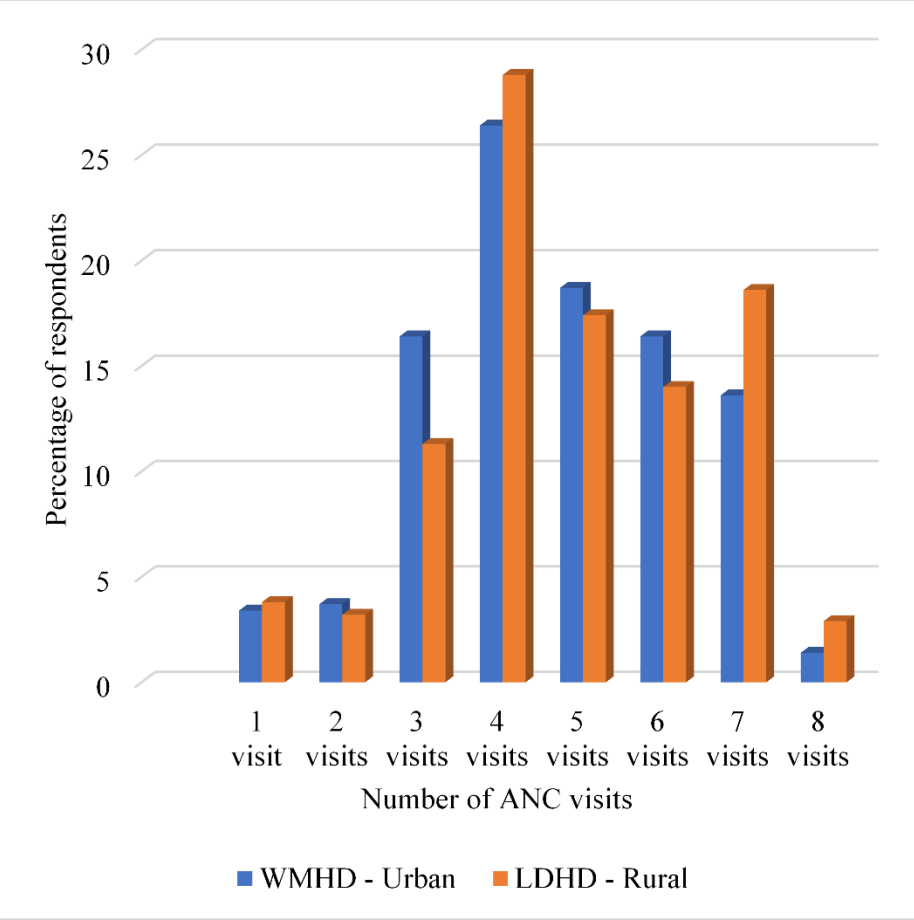
3.1.1.2 Obstetric and gynaecological characteristics

Table 12 shows the obstetric and gynaecological characteristics of 3rd-trimester pregnant women, including IPTp-SP and FA dosing. About three-quarters of the respondents were multigravida (gravida two or more), with more multigravida women in the rural than the urban area. Roughly 63% of the pregnant women attended the ANC service for the first time in their second trimester. 58% of pregnancies were within the first five weeks of their third trimester. The mean number of ANC attendances was 4.7 (range 1-8, standard deviation 1.6), and 92% of all ANC visits were routine visits. The number of SP doses taken for the current pregnancy ranged from zero to six doses (mean 3.2, standard deviation 1.3). 79% of the pregnant women had received SP combined with FA tablets (74% in the rural and 84 % in the urban area). Stockout of SP at the health facilities constituted 26% (16% in the urban, 36% in the rural study area) of the reasons why pregnant women missed their SP doses. Other reasons such as staff forgetfulness, mothers' excuse of not eating or being sick were further important hindrances to poor SP uptake, which dominated the urban study area (52%). For a better comparison between the ANC attendance and the SP doses taken, figure 9 presents the chartered details.

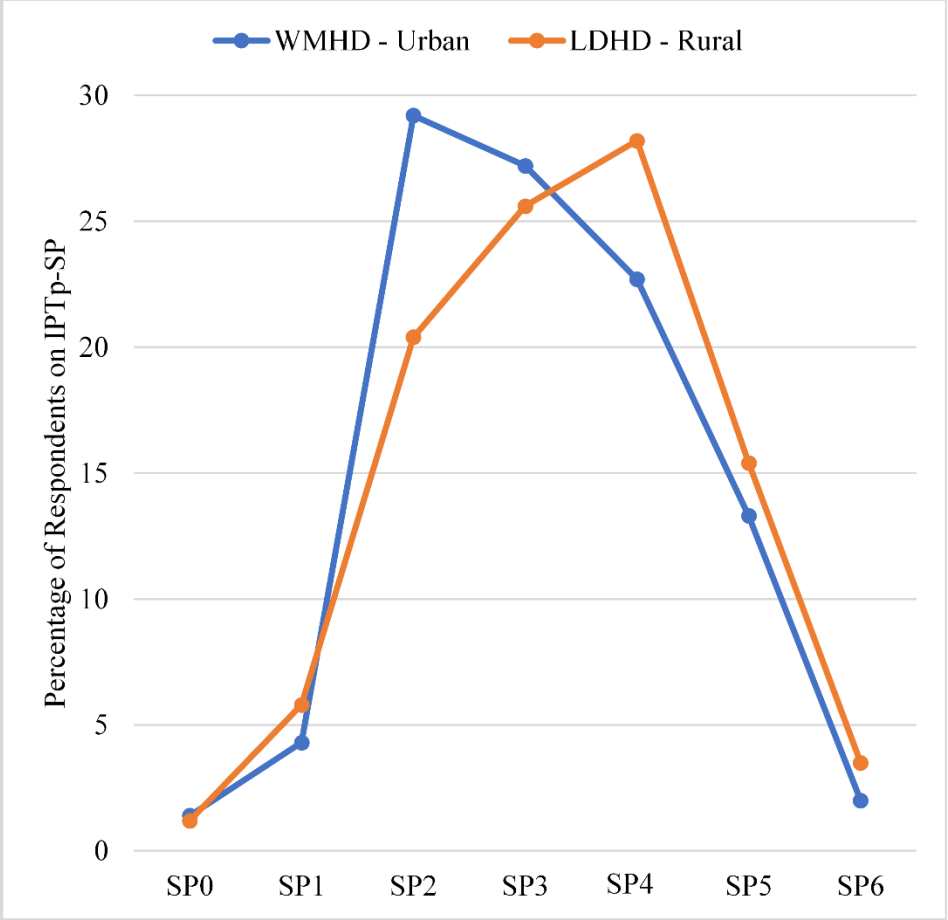
Table 12: Obstetric & gynaecological characteristics of pregnant women, and dosing of IPTp-SP and FA

Variable	Full sample		Urban		Rural	
	N=697	%	N=353	%	N=344	%
Gravidity						
Gravida 1	174	25	108	30.6	66	19.2
Gravida 2 or more	523	75.1	245	69.4	278	80.9
Gestational age at first ANC visit						
≤12 weeks	218	31.3	100	28.3	118	34.3
>12 to ≤24 weeks	436	62.6	230	65.2	206	59.9
≥25 weeks	43	6.2	23	6.5	20	5.8
Gestational age (on day of interview)						
25 – 30 weeks	405	58.1	211	59.8	194	56.4
31 – 36 weeks	230	33.0	113	32.0	117	34.0
37 – 42 weeks	62	8.9	29	8.2	33	9.6
Parity						
Nulliparous	183	26.2	115	32.6	68	19.8
Primiparous	172	24.7	104	29.5	68	19.8
Multiparous	327	46.9	131	37.1	196	56.9
Grand multiparous (≥5)	15	2.2	3	0.8	12	3.5
ANC visit						
1	25	3.6	12	2.4	13	3.8
2	24	3.4	13	3.7	11	3.2
3	97	13.9	58	16.4	39	11.3
4	192	27.6	93	26.4	99	28.8
5	126	18.1	66	18.7	60	17.4
6	106	15.2	58	16.4	48	14.0
7	112	16.1	48	13.6	64	18.6
8	15	2.1	5	1.4	10	2.9
Reason for missed SP doses (only those who had ≤SP2)						
Missed ANC schedule	52	24.0	21	17.1	30	32.9
SP Shortage at facility	73	33.6	24	19.5	47	50.0
Others ('not eaten', staff forgetfulness, sickness)	92	42.4	78	63.4	17	18.1
Number of SP doses taken for current pregnancy						
None (0)	9	1.3	5	1.4	4	1.2
SP1	35	5.0	15	4.3	20	5.8
SP2	173	24.8	103	29.2	70	20.4
SP3	184	26.4	96	27.2	88	25.6
SP4	177	25.4	80	22.7	97	28.2
SP5	100	14.3	47	13.3	53	15.4
SP6	19	2.7	7	2	12	3.5
Administered SP & 5mg Folic Acid (FA)						
Yes	549	78.8	295	83.6	254	73.8
No	148[b]	21.2	58[b]	16.4	90[b]	26.2

[b]: Indicated that FA was not taken on the day of the ANC visit.



Bar chart of ANC Visits for urban and rural.



Line graph of SP doses taken for urban and rural.

Figure 9: Percentages of ANC VISITS and SP Uptake in Rural and Urban Areas

3.1.1.3 Knowledge of pregnant women on risks of malaria in pregnancy

Table 13 shows the respondents' knowledge of malaria risks in pregnancy (MiP) aggregated from the urban and rural areas. Overall knowledge of the causes and prevention of malaria was good (67%) but with large variations on the specific questions that were asked. Particularly, only 19.5% had correct knowledge on the possible effect of malaria on the unborn child.

Table 13: Knowledge of pregnant women on risks of malaria in pregnancy

Knowledge of malaria in pregnancy (N=697)

Knowledge parameter	**Freq**	**%**
The main cause of malaria	576	82.6
Main methods used to protect yourself against malaria	671	96.3
Malaria in pregnancy can harm your unborn child	437	62.7
Ways malaria can harm you and/or your unborn baby	136	19.5
The first SP is enough to protect you throughout pregnancy	205	29.4
Only sick (of malaria) pregnant women need to take SP	593	85.1
Do you think the SP therapy rather harms your unborn child	653	93.7
Mean knowledge score	**467**	**67.0**

Source: Fieldwork (2019)

3.1.1.4 Professional characteristics of ANC nurses and midwives

Information on the professional background and service-related challenges of the 64 ANC nurses interviewed is provided in Table 14. The majority were either trained as community health nurses or as midwives. Roughly three-quarters of the nurses in the urban area had provided ANC services for four years at most compared to 86% of the nurses in the rural area. 88% of the nurses had experienced stock-outs of SP every other week or at least monthly (about 90% across urban and rural area). 16% had experienced stock-outs even daily or weekly basis. Nurses also reported that it usually takes longer than one week to restock the SP. Some of the staffs indicate that the FA usually comes already packaged in 5mg blisters. In the urban area, 61% of the nearest referral facilities were within a 5 km distance. In contrast, 61% of the referral facilities in the rural area, were more than 15 km away.

Table 14: Professional background and service-related characteristics of ANC nurses

Parameter	Full sample N=64 (%)	Urban N=26 (%)	Rural N=38 (%)
Professional background per training			
Midwife	27(42.2)	14(53.9)	13(34.2)
Community Health Nurse (CHN)	27(42.2)	7(26.69)	20(52.6)
Other	10(15.6)	5(19.2)	5(13.2)
Any midwifery related training on the job (Yes/No)	23(35.9)/41(64.1)	10(38.5)/16(61.5)	13(34.2)/25(65.8)
Years of work on this role (ANC)			
≤ 2rs	28(43.8)	9(34.6)	19(50.0)
≤ 4yrs	25(39.0)	11(42.3)	14(36.8)
≥ 5yrs	11(17.2)	6(21.4)	5(13.9)
Distance to the nearest referral facility			
≤ 5km	19(29.7)	16(61.5)	2(5.3)
6km – 10km	9(14.1)	2(7.7)	6(15.8)
11km – 15km	10(15.6)	4(15.4)	7(18.4)
≥ 15km (- 45km)	26(40.6)	4(15.4)	23(60.5)
Have experienced SP stock out (Yes/No)	56(87.5)/8(12.5)	23(88.5)/3(11.5)	33(86.9)/8(21.1)
Frequency of stock out	*N=56*	*N=23*	*N=33*
Daily	4(7.1)	1(4.3)	3(9.1)
Weekly	6(10.8)	5(21.7)	1(3.0)
Other (every other week or more)	46(82.1)	17(73.9)	29(87.9)

3.1.2 Analytical Findings

3.1.2.1 Determinants of SP uptake among pregnant women

Table 15 presents the Poisson model results on the SP uptake as the outcome variable among pregnant women. The number of maternal ANC visits (IRR= 1.26, 95% CI: 1.221-1.299) and their gestational age at 1st ANC (IRR= 0.84, 95% CI: 0.623-1.127) were significantly associated with SP uptake as expected. This means that pregnant women who registered for ANC early enough (within the first trimester of pregnancy) were much more likely to receive optimum SP doses than late registrants.

Table 15: Poisson regression of determinants of SP uptake in pregnant women of northern Ghana

SP Uptake		IRR	95% CI		p-value
Maternal age		1.000	0.993	1.008	0.931
Marital status					0.502
	Married	ref			
	Not married	1.067	0.883	1.289	
Occupation					0.932
	farming	ref			
	public/civil service	1.027	0.816	1.293	
	private/personal business	0.977	0.833	1.146	
	Unemployed	0.970	0.802	1.173	
Formal Education					0.928
	Any	ref			
	None	1.004	0.911	1.107	
Income					0.910
	Below minimum wage (≤ 299)	ref			
	On minimum wage (300 to 599)	0.974	0.811	1.169	
	Above minimum wage (≥ 600 - 1800)	0.956	0.743	1.23	
Gestational Age at 1st ANC					**0.006**
	≤12 weeks	ref			
	>12 to ≤24 weeks	1.132	1.023	1.253	
	≥25 weeks	0.838	0.623	1.127	
Parity					0.329
	Nulliparous	ref			
	Primiparous	1.084	0.961	1.222	
	Multiparous (2-3)	1.017	0.901	1.149	
	Grand multiparous (4-8)	1.145	0.938	1.399	
Household Size	(1 to 12)	0.994	0.973	1.017	0.614
Own ITN					0.659
	no	ref			
	yes	1.033	0.896	1.195	
Knowledge score	(1 to 7)	1.002	0.965	1.04	0.935
ANC visits	(1 to 8)	1.255	1.212	1.299	**<0.001**
District					0.892
	Urban area (WMHD)	ref			
	Rural area (LDHD)	1.006	0.917	1.104	

IRR = *Incidence risks ratio*

3.1.2.2 Determinants of ITN use

Table 16 presents binomial logistic regression on the use of ITN and sociodemographic characteristics of respondents. The binomial regression analysis shows that the main determinants of use of ITNs include good maternal knowledge of the risks of malaria in pregnancy (OR=1.8, 95%CI: 1.1-2.8), owning an ITN (OR=2.5, 95%CI: 1.3-4.5), and more ANC visits (OR=1.3, 95%CI: 1.0-1.5). The gestational age character at first ANC registration

varies according to trimesters: both third (OR=4.6, 95%CI: 1.4-15.1) and second-trimester women (OR=3.2, 95%CI: 1.9-5.7) were statistically significant to ITN use compared to first trimester women. Religious affiliations (Muslim OR=0.6, 95%CI: 0.3-1.0, and African traditional religion OR=0.1, 95%CI: 0.1-0.8) also showed statistically significant influence on ITN use compared to Christianity, and marital status (OR=0.3, 95%CI: 0.1-0.6). However, the rural-urban comparison and other characteristics, did not show a statistically significant influence on ITN use.

Table 16: Sociodemographic and gynaecological characteristics on use of ITN

Use of ITN (Yes/No)[a]	Sub-Categories	OR	[95% Conf.	Interval]	P>z
Age		1.0	0.9	1.1	0.061
Marital status	*Married*	ref			
	Single	0.3	0.1	0.6	0.002*
Family type	*Polygamous*	ref			
	Monogamous	1.2	0.7	1.9	0.463
	Not married	1.7	0.1	26.5	0.715
Occupation	*Farming*	ref			
	Public/civil service	0.7	0.3	2.0	0.524
	Private/personal business	1.8	0.8	3.8	0.126
	Unemployed	1.9	0.8	4.5	0.159
Monthly income	*Below Poverty line (GHS0-299)*	ref			
	Within poverty line GHS 300-599	0.9	0.3	2.3	0.799
	Above poverty line GHS600-1800	0.7	0.2	1.9	0.468
Religion	*Christian*	ref			
	Muslim	0.6	0.3	1.0	0.045*
	Traditional African Religion	0.3	0.1	0.8	0.023*
Formal education	*Yes*	ref			
	No	1.1	0.4	3.3	0.800
Level of education	*Primary*	ref			
	Junior High	0.8	0.3	2.5	0.750
	Senior High	2.5	0.8	7.8	0.110
	Tertiary	1.2	0.4	3.8	0.750
Household size		1.0	0.9	1.2	0.362
Gestation_at_1st_ANC	*1st Trimester*	ref			
	Second trimester	3.2	1.9	5.7	0.000*
	Third trimester	4.6	1.4	15.1	0.010*
Number of ANC visits		1.3	1.0	1.5	0.018*
Parity	*Nulliparous*	ref			
	Primiparous	0.6	0.3	1.1	0.131
	Para 2 to 3	0.9	0.5	1.6	0.684
	Multiparous (4-8)	0.4	0.2	1.1	0.064
Own an ITN	*No*	ref			
	Yes	2.5	1.3	4.5	0.004*
Knowledge of MiP[b]	*Poor*	ref			
	Good	1.8	1.1	2.8	0.014*
Study District	*Urban*	ref			
	Rural	0.9	0.5	1.3	0.333

[a]Use of ITN was defined as having slept under an ITN the previous night or more, according to scientific literature| [b]MiP: Malaria in Pregnancy| Statistically significant at *p<0.05

3.2 QUALITATIVE RESULTS

3.2.1 Descriptive

3.2.1.1 Pregnant Women's Challenges in Accessing and Adhering to IPTp-SP Protocol

The responses from the six FGDs were categorized according to the themes, as shown in Table 17. Most of the defaulting pregnant women had a fair knowledge regarding the cause of malaria and measures to prevent mosquito bites: answers generally contained phrases such as '*…through mosquito bites*', '*…by a mosquito'*, '*if I get malaria, it can affect my baby because*

the baby is inside me', etc. However, even though on few instances, responses such as '*it is caused by the food we eat*', '*through cold food*', '*through dirty water or dirty environment*', etc. also indicate that an average of 13% (6/48) have poor knowledge about the cause of malaria. Under the theme 'challenges in accessing IPTp-SP', frequent *shortage* of SP was mentioned. Many women were told they need to buy the drugs from the private market or return on a scheduled date to receive them. A mother's response summarizes this challenge:

"Sometimes too when we struggle to come here [health facility]*, they* [nurses] *will check you all right but say the medicine* [SP drug] *is finished, so you should return the next week or sometimes too they write for you to go and buy. Do you know how I come here or if I have the money to buy it* [the SP drug] *or not?"* (Participant, FGD2_WMHD).

Some 23% (11/48) of the pregnant women also mentioned discomfort (nausea, vomiting, weakness…) as signs of *adverse drug reactions* - ADR) as their reason for defaulting. Other reasons for poor uptake to IPT-SP was "negligence by the service provider" supported by comments like '*service provider absenteeism or forgetfulness*', or '*their poor knowledge of the importance of SP*'. Participants also complained that the men should join them on ANC days to be informed about the cost of services and other expectations:

"*You also see something, hmmm… our husbands too, ehmm… our husbands don't believe us when we pass messages to them at home; so, if usually they are involved with for the ANC, it would be easier for them to understand and support us better*" (Participant, FGD1_LDHD).

Some 42% (10/24) of the FGD participants in the rural district reported '*mistreatments*' and '*extortions*' they encountered at a facility where they need to go for ultrasound scans and other blood tests at least once during their pregnancy. A mother's quote on the quality of services she received (like reused urine containers) and extra costs of services at a facility is captured below:

"We also pay for everything, even though my insurance [referring to public health insurance] *is active. You need about 115 cedis* [$19.8] *to attend …. hospital and sometimes you must sleep overnight to get your results before you come home, and it is not only once you have to go there before you deliver. Where should that money come from?"* (Participant, FGD1_LDHD).

This appeared as a shared experience of many other women in this focus group. They unanimously confirmed their colleague's concern loudly, followed with what seemed like a competition to each narrate their ordeal at this facility. Participants also revealed their frustration with staff absenteeism and the fact that they, as direct beneficiaries, do not know the significance of the IPTp-SP. These were captured in mothers' comments as presented in the following quotes:

"If you people [referring to FGD moderators] *can also make sure that the nurses are always present every time to attend to us, it will be really good. There are times some of us will stop our work at home and struggle in the hot sun to come here on foot, but we do not meet any nurse to talk to us. If I do not even have any coin to buy water to drink, will I come again the next time? I will intentionally forget"* (Participant, FGD1_LDHD).

"When you know the benefits, you will sacrifice whatever it takes for the goodness of your unborn child, but when you do not know, then you won't. Who doesn't want comfort?" (Participant, FGD_WMHD)

Table 17: Qualitative findings from FGDs in urban (WMHD) and rural (LDHD) districts on IPTp-SP Intervention

Theme	Sub-code	Verbatim Quotes
Knowledge	Good knowledge	*"If I get malaria, it* [malaria] *can affect my baby in the womb because the baby* [fetus] *is exposed to any sickness I get. So, we should worry because of the child in the womb"* (Participant, FGD3_LDHD)
		"Some of us either sleep under the mosquito net or spray the rooms to prevent mosquitoes. Some of us also cover ourselves with clothes to prevent mosquito bites or use the mosquito coils…" (Participant, FGD2_WMHD)
	Poor knowledge	*"Malaria is caused by the kind of food we eat or living in* [an] *environment in which there is filth or dirty water"* (Participant, FGD1 LDHD)
		Sometimes too eating cold food can cause malaria: so, we are always told not to be eating very cold foods during pregnancy" (Participant, FGD2_WMHD)
		"For me, I think it is because of ignorance of some of us. If the nurses talk to us, some will change but not all because others will not take it anyway" (Participant, FGD2_LDHD).
Challenges in accessing IPTp-SP	Provider negligence	*"Sometimes it is from the nurses! Since I have been going to the facility, only once they* [nurses] *gave it* [SP] *to me. Meanwhile, I am almost due to give birth. They did not tell me to take it or not; I didn't also remind them."* (Participant, FGD1_LDHD).
		"For me, I do not feel anything bad when I take it. I feel completely ok with it; because of that, I always remind the nurses anytime they forget to give me. The last time, I kept reminding them that I have not taken my second dose until they gave me" (Participant, FGD3_WMHD).
		"*If the nurses can always be present to attend to us, it will be good. At times, we struggle in the hot sun to come here on foot, but we do not meet any nurse to talk to us. If I do not have any coin to buy drinking water… I will intentionally forget the next visit*" (Participant, FGD1_LDHD).
	SP stockout (44%, 21/48)	*"Sometimes too when we struggle to come here* [health facility]*, they* [nurses] *say the medicine* [SP drug] *is finished, so you should return the next week, or sometimes too they write for you to go and buy. Do you know how I come here or if I have the money to buy it or not?"* (Participant, FGD2_WMHD)
	Change of residence	*"For me, the only reason why I skipped was that I was away. I got pregnant in Niger and came back here to Ghana, so the change of environment distracted the dosage in-take"* (Participant, FGD2_WMHD).
	Adverse drug reaction	*"It* [SP] *disturbs my body and makes me either shiver or vomit. Anytime I take it I feel that my body is shaking"* (Participant, FGD3_LDHD)

		"It [SP] *also makes you feel like you have malaria, but when you complain, the nurses still encourage you to take it* [SP]*. They* [health providers] *say though it gives symptoms like malaria, it also prevents malaria"* (Participant, FGD3_LDHD)
Improving uptake to IPTp-SP	Health education	*"When you know the benefits, you will sacrifice whatever it takes for the goodness of your unborn child…. Who doesn't want comfort?"* (Participant, FGD1_WMHD).
	Encouragement	*"For me, I think the nurses should always insist we take it. The last time I went to the facility, they stood on me until I swallowed it* [the SP]*; I had to buy water that day when I told them I did not have water"* (Participant, FGD3_LDHD)
		"They should always insist that we take [the drug] *at the facility. The way it* [SP] *disturbs when you take it, it is not easy, because of that it is good they insist that we take it"* (Participant, FGD1_WMHD).
	Improve monitoring and evaluation	*"The nurses should make sure the SP drug is always available. They should also prescribe it for us to buy it in case it is not available at the facility."* (Participant, FGD1_WMHD).
	Individual circumstance	*"Sometimes too, it is because you have not eaten anything. So, we feel reluctant on such occasions because you may feel weaker and uncomfortable taking it in a hungry stomach"* (Participant, FGD1_WMHD)
		"It is better always to take it [SP] *home. Else, some of us cannot swallow drugs without putting it in the TZ* [a local meal of flour]*; we cannot swallow it with water. So, it is difficult for us whenever we are asked to take it and swallow immediately"* (Participant, FGD2_LDHD)

Source: Fieldwork (2019)

3.2.1.2 Understanding of the Cause and Prevention of Malaria

Figure 10 presents an overview of respondents' general knowledge regarding the cause of malaria and some of the ways they can prevent themselves from getting infected. Respondents' answers indicate that, generally, they have good knowledge of the cause and prevention of malaria. Regarding the cause of malaria, the factor of 'poor environmental such as *"stagnant waters…"*' show that respondents are aware of how their environment can support the survival of the malaria vector. Others also precisely identified the '*bites from a mosquito*' as the cause of malaria. In contrast, others still think malaria is caused by '*eating cold food or drinking cold water, or even cold weather*'. On the aspect of prevention, '*the use of an ITN*' was frequently mentioned compared to other measures such as '*the use of insecticide sprays, or repellents*'.

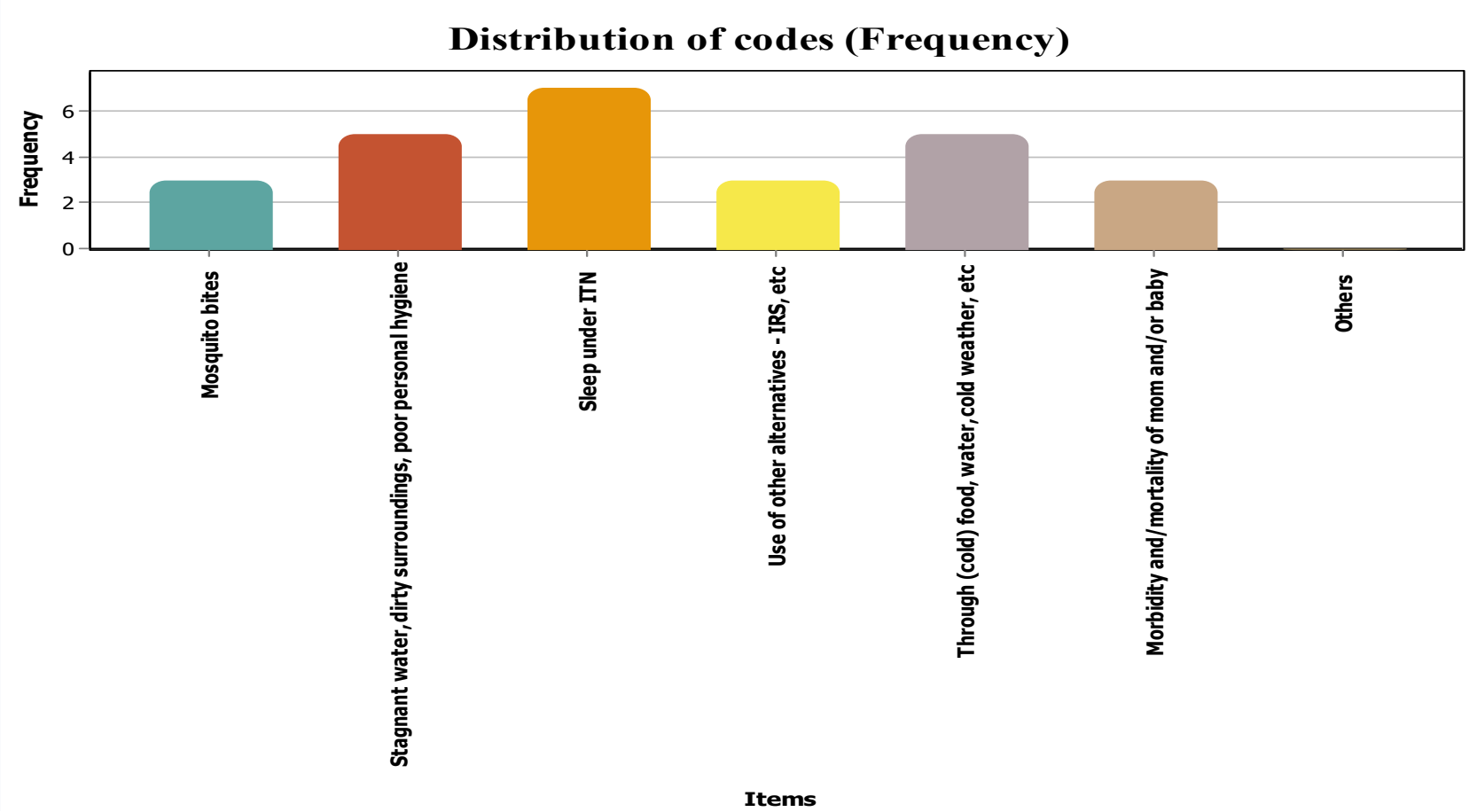


Figure 10: Basic knowledge of Cause and Prevention of malaria

3.2.1.3 Challenges to the use of ITNs among pregnant women

Figure 11 presents the word cloud of expressed challenges to regular use of ITNs among pregnant women. The most frequent reason for the non-regular use of ITNs by these pregnant women was the sleeping discomfort of heat, skin itching and rashes that mothers said they experienced, as contained in the following statements by some participants:

"*For me, I get facial rashes and itches anytime I sleep inside the mosquito net, either because of the chemical used to spray the nets. It will be good also if they make the mosquito nets more air-friendly, I do not know how that can be done, but that will make it better for us to sleep in it."* Participant, FGD1_WMHD.

"The net inside? I cannot sleep inside; it is because of the heat." Participant, FGD3_WMHD

Pregnant women also complained about the lack of or inappropriate hanging structures in their homes to enable them to hang the nets over their beds and that this will could be less problematic if all the ITNs are designed in a conical shape with one hanging rope rather than the rectangular shape with four ropes:

"*Some of us, how to mount it* [the ITN] *is always the problem: we have to use many nails to pin on the walls before we can mount it, but most landlords do not allow us to use nails on their walls. So, that prevents us from using"* Participant, FGD3_WMHD

The third and fourth pronounced challenges were '*staff attitude*' and '*insufficient or lack of spousal support*' (Figure 11):

"Sometimes, you can come for the weighing and check-up and wait for a long time, whiles they are sitting down doing other things. Moreover, we have many things to do, you end up doing nothing for the day. Sometimes too, we do not eat, and come to the facility early with the hope of going back early to eat but end up sitting with the hunger waiting to be attended to by the nurses." Participant, FDG2_LDHD

"Sometimes we give birth even without the knowledge of our husbands; they will somewhere even while you are still on the bed giving birth, he is thinking of marrying another woman" Participant, FGD3_WMHD.

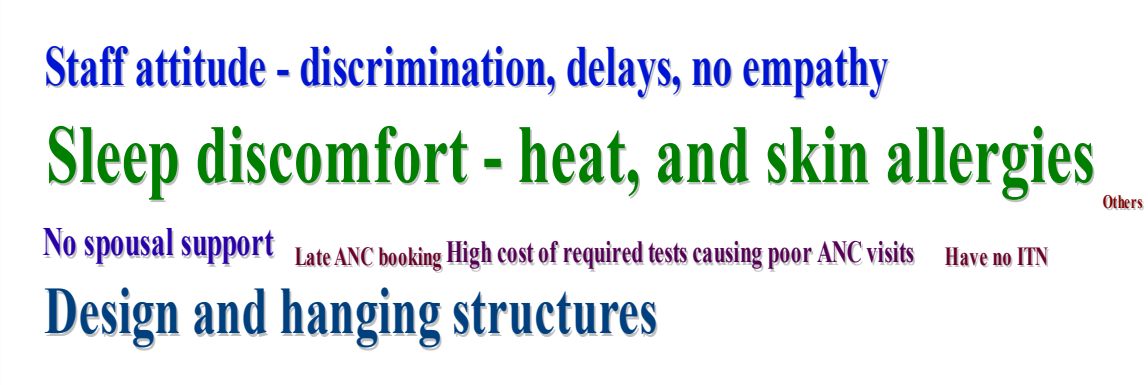


Figure 11: Highlighted challenges to regular use of ITN

3.2.1.4 Proposed ways to facilitate regular use of ITNs.

Pregnant women are the end-users of ITNs. So, proffering solutions to the highlighted challenges is comparably a more holistic approach if done from their perspectives (Figure 12). Out of the many needs expressed during the discussion of this theme, the most significant of them was their need for more '*education and encouragement from service providers*', as beautifully put by some participants:

"For me, motivation from the nurses, education on the importance of it, telling us more on the consequences of sleeping outside the mosquito net will help us." Participant, FGD2_LDHD

"They should be motivating us, boxing [cajoling] *us, etc., especially whenever we get to the weighing ground* [referring to the ANC] *at the facility. It will encourage us to use the ITN and the SP."* Participant, FGD1_LDHD

Additionally, pregnant women felt that if service providers through the community health volunteers (CHVs) and/or made regular visits to their homes or phone calls as reminders, it would help to ensure adherence to the use of their ITNs:

"…but even when you test at home and know that you are pregnant and get to the facility, they [referring to nurses] *still insist that you test and pay the 5 Ghc* [$1.00] *or 3 Ghc* [$0.52] *… that is preventing people from going for the ANC booking early. We rather wait till their tummies are visible then visit the facility. At that moment, the nurses cannot insist on the test any longer.*" Participant, FGD1_LDHD

Other important and equally expressed needs included the '*need for their spouses to be more actively involved in their pregnancy care requirements and services*' as well as 'others' such as the reduction or total removal of cost in pregnancy test at the ANC:

"For me, my husband used to pick me to the facility for my first and second pregnancy, but subsequently he does not do that, anytime I asked him, he will tell me his colleagues will tease him as someone who is always following the back of women, and for that matter, he will not pick me to the facility again. For the Muslim men, they keep influencing one another, and that is the problem; they say their colleagues will laugh at them, that is the reason", Participant, FGD3_WMHD

"I suggest that they allow us rather to use the NHIS card to pay for the cost of the test instead of demanding for the cash payment." Participant, FGD1_LDHD

Figure 12: Suggestions to improve adherence to ITN use.

4 DISCUSSION

This chapter of the dissertation is presented in two main parts and under the specific objectives of this study. The first part covers the study findings on the IPTp-SP intervention. In contrast, the findings on the ITNs intervention are discussed in the second part. The discussion on each intervention in each of these two sections is presented according to the study objectives.

4.1 Determinants of uptake of IPTp-SP

Pregnant women are the most at-risk adult population for malaria, which justifies IPTp administration (Population Reference Bureau, 2001; WHO, 2017c). WHO recommendations call for at least three doses of IPTp-SP to be given to women in the malaria-endemic areas of SSA during pregnancy, but overall uptake remains low (WHO, 2018d). In 2016, SP3 coverage was achieved by only one-fifth of eligible African pregnant women (World Health Organization, 2018). Our study's main finding supports this finding, as only 26.4% of the pregnant women had received SP3. This coverage is even much lower compared to the findings from another study conducted in northern Ghana (Anto et al., 2019). The uptake level of SP3 in the current study population is also much lower than the 60% national average of SP3 in Ghana (Yaya et al., 2018). However, it needs to be considered that the methodology of these studies was slightly different from the methods used in our study. Factors identified in our study which affected SP uptake were frequent stock outs of SP in the local health facilities, poor maternal knowledge of the importance of the IPTp intervention, and staff absenteeism. These data support similar observations from other countries in SSA (Rassi et al., 2016; Hill et al., 2013). Another reason that could be an explanation for our finding of a rather good ANC attendance, but low SP uptake could be that the ANC nurses would normally adjust the ANC schedule between 28 to 36 weeks into gestation (according to the

condition of the client) to bi-weekly visits, to increase the monitoring frequency and to avoid home deliveries. This doubles the frequency of ANC visits while the SP therapy remains monthly. A potential effective intervention to increase IPTp coverage could be the involvement of community health workers, as recently shown in a cluster randomized controlled trial in Burkina Faso (Gutman et al., 2020).

Maternal commitment to the uptake of IPTp-SP plus FA throughout pregnancy in malaria-endemic areas has a double benefit for pregnant women and their new-borns; It reduces maternal and fetal anaemia, low birth weight and neonatal mortality through the reduction in maternal malaria episodes and placental malaria parasitaemia by 65 to 85% (Shulman et al., 1999; WHO, 2017c). Another significant finding from this study was the fact that IPTp-SP was frequently co-administered by a high dose of FA (5mg), which is clearly against the national and international policy recommendations to only provide 0.4mg FA (Ghana Health Service, 2016; National Malaria Control Programme, 2016). FA at a daily dose equal to or above 5mg should not be given together with SP in malaria-endemic areas as this reduces the antimalarial efficacy of SP and is considered as an independent risk factor for SP treatment failure (Carter et al., 2005; Peters et al., 2007; WHO, 2013; Ghana Health Service, 2016; WHO, 2018c). The 5mg of folic acid per day is only recommended for peri-conceptional supplementation in women who had a previous pregnancy with a child with a neural tube defect (NTD) (De-Regil et al., 2015). A review about the availability of 0.4mg FA on the Ghana national emergency medicine lists revealed that folic acid at a dose of 0.4 mg is only available in combination with iron. In addition, the price for this combination (0.41 GHC) is much higher than the price for 5mg FA tablets (0.02 GHC) or 60mg ferrous sulphate tablet (0.05 GHC) in Ghana (National Health Insurance Scheme, 2020). Currently, there is no

scientific consensus, whether high doses of FA should be withheld (and for how long) following the dose of SP in malaria-endemic areas where only high-dose FA is available (WHO, 2018c). It is a general policy that pregnant women are administered the SP therapy, unlike the FA, as directly observed therapy (DOT) at the ANC consultation. The FA, however, is prescribed to be taken daily, self-administered at home, until the next ANC visit (WHO, 2018c). This has also been discussed in the 2016 desk review report on barriers to IPTp-SP uptake in Ghana (GHS-NMCP, 2016). One more problem could be that, according to WHO, in areas where the prevalence of anaemia in pregnancy is higher than 20%, a high dose of 5mg FA is still recommended (WHO, 2009; Ba et al., 2019). However, this contradicts the IPTp-SP recommendation for 0.4mg FA daily (WHO, 2013; WHO, 2018a; Peters et al., 2007). There is a need for making pre-packaged combinations of SP plus optimum-dose FA available and more accessible in SSA.

Our data also demonstrated that pregnant women with more ANC visits are more likely to get their SP than those with fewer ANC visits. This has also been shown elsewhere (Chepkemoi Ng'etich Mutulei, 2013). It is not surprising because SP is administered only at the ANC based on directly observed therapy (DOT). Moreover, pregnant women whose gestational age at first ANC was within the first trimester had received more SP doses than those who started ANC visits later, again supporting findings from other studies (Azizi, 2020; Anto et al., 2019). According to the ANC nurses interviewed in our study, the biggest challenge for IPTp-SP uptake was frequent SP stock stock-outs and significant delays in restocking as reported elsewhere (Muhumuza et al; Ameh et al., 2016). This finding was confirmed by many of the pregnant women in the FGDs. Other challenges for IPTp-SP uptake identified from the FGDs included staff absenteeism, especially in the rural area, and inadequate maternal knowledge of the IPTp-SP intervention.

Stock-outs of freely supplied essential medicines such as SP in peripheral health facilities appears to be a persistent problem across many malaria-endemic countries in SSA (Kanté et al., 2014; Bajaria et al., 2019; Marchant et al., 2008; Amankwah & Anto, 2019). Identified health system challenges associated with stock-outs of essential drugs in Ghana were a limited local pharmaceutical capacity, grossly underfunding by international donors, as well as the bureaucratic demands on importing drugs (Odjidja et al., 2017). However, it has also been observed that SP stock out is frequently due to its non-recommended use as a monotherapy in clinical malaria cases (WHO, 2013).

4.2 Determinants of ITN Use

The regular and proper use of ITNs is one of the most effective ways to avoid mosquito bites and contracting malaria (Hill et al., 2014; Gamble et al., 2006). Comparable to findings elsewhere (Oladimeji et al., 2019), over three-quarters of the 89% respondents who owned ITNs in this study also use them, unlike findings reported in other studies (Ankomah et al., 2012; Fuge et al., 2015; Obol et al., 2011). However, it is essential to note that, unlike our study, which is facility-based, the studies of Ankomah et. al., and Fuge et al., were both household surveys. Therefore, our facility-based findings of high ITN ownership, as well as high ITN usage, could be due to response bias. Our study further revealed that good maternal knowledge of the risks of malaria in pregnancy, ownership of an ITN, more ANC visits, and the mother's gestational age first ANC registration are statistically significant determinants of the regular and proper use of ITNs in the study area. Our data shows that mothers with good knowledge of risks of malaria in pregnancy had 1.8 higher odds of using an ITN compared to those with insufficient knowledge while owning an ITNs had increased the likelihood of its use by 2.5 times. Our finding of the strong correlation between

knowledge of malaria in pregnancy and use of ITNs is similar to findings of related studies (Adebayo et al., 2014; Ankomah et al., 2012; Ezire et al., 2015). In terms of maternal educational background, our study did not find any significant correlation to ITNs use, as reflected in some studies (Adebayo et al., 2014; Oladimeji et al., 2019), but contrary to reports from a WHO commentary and a number of other studies (WHO et al., 2018; Oladimeji et al., 2019). This shows that behaviour change is not just influenced by knowledge per se or formal education but by knowledge particular to the needs of the target audience (Adebayo et al., 2014). Maternal gestational age at first ANC and more ANC visits in this study also showed a strong correlation with the use of ITNs. This is not surprising because the ITNs are often distributed to pregnant women at the ANC facilities upon registration and/or during ANC visits (Hill et al., 2014; Beiersmann et al., 2010). However, pregnant women who registered at ANC in their third trimester and second trimester were about five times and 3 times, respectively, more likely to use their ITNs than those who registered for ANC during their first trimester. This means that the longer a pregnant woman delays visiting the ANC for registration, the more likely she was to use her ITN. The plausible reason for this observation could be that those pregnant women who delay registering at the ANC have more confidence in getting more protection from their ITNs, and therefore do not feel an urgency of registering early at the ANC. Our findings of strong correlation between gestation at registration, more ANC visits and ITN use are similar to findings of other related studies conducted elsewhere (Ankomah et al., 2012; Obol et al., 2011; Hill et al., 2014).

Our study also revealed that marital status was associated with regular use of ITNs in that single pregnant women had 0.3 lesser odds of using their ITNs compared to married pregnant women. This finding agrees with reports of a similar study where unmarried women also had lesser odds

of using their ITNs (Hill et al., 2014). Also, in a WHO commentary and related studies, marital status was a strong determinant of ITN use (WHO et al., 2018; Oladimeji et al., 2019). Our finding could be explained by the possibility that married women enjoy the benefits of spousal support, unlike single women who may have to manage the pregnancy-related and resource-demanding needs on their own. Maternal religious affiliation also played a role in respondents' decision to use their ITNs in that, ATR-affiliated pregnant women had 0.3 lesser odds. In comparison, Muslim pregnant women had 0.6 lesser odds to ITN use compared to Christian pregnant women. This means that ATR and Muslim pregnant women were less likely to use their ITNs than their Christian counterparts. The findings of religion as a possible determinant of ITN use agrees with another study in the northern part of Ghana (Kanmiki et al., 2019) but is not supported by findings of a related study among Ugandan women (Obol et al., 2011). Our finding could be explained by the revelation from our focus group discussion that Christian men were more supportive to their spouses compared to their Muslim colleagues (Figure 11). Similar to other studies, our study did not find any significant differences between rural and urban pregnant women in ITN use (Oladimeji et al., 2019), which contradicts findings of a similar study in northern Ghana (Kanmiki et al., 2019).

4.3 Challenges to access and use of ITNs.

The purpose of the focus group discussions was to identify and understand the challenges to access and utilization of ITNs from the pregnant women's perspective. From the results, the most obvious challenge to the desired use of ITNs was the experience of '*sleep discomfort*'. Pregnant women frequently mentioned that they experienced different discomforts in using their ITNs, such as '*heat or the feeling of excessive warm*' and '*skin rashes*', among others (Figure 12). Other pronounced

challenges included the '*lack of or inappropriate hanging structures'* to mount their ITNs and the '*attitude of ANC staff such as delays, lack of empathy, and discrimination based on educational background*' where educated women were preferentially served before uneducated women. Pregnant women also highlighted the 'lack of or insufficient spousal support' as a factor affecting their use of ITN in that, women who attended ANC with their spouses were prioritized over those whose husbands do not accompany them to the ANC. This is a strategy by the health service providers to encourage men's participation and support in their wives' ANC journey. Comparable to our finding on sleep discomforts and no hanging structures, Adebayo and his colleagues found similar reasons among pregnant women in Nigeria (Adebayo et al., 2014) since these were recorded by other similar studies (Oresanya et al., 2008; Marin & Baume, 2007; Manu et al., 2017b).

4.4 Proposed ways of mitigating challenges to ITN usage

To proffer workable solutions to the challenges pregnant women encounter in accessing and using ITNs, it was significant to solicit and understand their perspective of what works for them or not in their respective situations. This part of our discussion chapter is presented without related scientific literature because most of the scientific studies which explored the challenges to ITN use usually do not explore the solutions to those challenges from the user perspective. Instead, the authors often inferred the solutions from the identified challenges rather than from the ITN users. However, this study sought both challenges and the preferred solutions to ITN use from the user point of view.

Pregnant women in this study strongly expressed their need for more education to increase their knowledge regarding the dangers of malaria, the importance of malaria interventions and motivation to use ITNs. Women also acknowledged that regular reminders from their community health volunteers and service providers in the form of home visits or phone calls would be significant in ensuring their compliance to ITN use. A section of the women also indicated that encouraging spousal support and involvement throughout their pregnancy journeys, especially at ANCs, will play a significant role in their compliance to ITN use and other healthy lifestyles. They believe that involving their spouses will help build an understanding of the challenges, the risks of non-compliance to interventions and the requirements expected of them by the service providers to ensure a healthy pregnancy.

5. SUMMARY

Background: The disease of malaria has remained a significant public health problem in endemic countries, especially in sub-Saharan Africa (SSA). The disease is even far devastating among vulnerable and the most at-risk populations of pregnant women and children under five years. Existing interventions such as intermittent preventive therapy in pregnancy (IPTp) using sulfadoxine-pyrimethamine (SP) and the regular use of insecticide-treated bed nets (ITNs) are very effective against malaria, especially placental malaria. However, low uptake to these interventions is a challenge across SSA, often resulting in substantial malaria-related morbidities and mortalities of pregnant women, infants, low birth weights, as well as miscarriages. This study assessed the personal and the health system-related factors affecting the expected uptake of IPTp-SP and ITNs among pregnant women in Ghana.

Objective: the study was conducted to address four main objectives as follows:

1. To estimate the distribution of IPTp-SP uptake and the ownership and usage of ITNs among pregnant women in urban and rural Ghana.
2. To determine the personal and health system factors that influence IPTp-SP and ITN use among pregnant women.
3. To measure the knowledge of pregnant women of the risks of malaria in pregnancy and the knowledge of the ANC providers on implementing the SP policy protocols in Ghana.
4. To assess the dosage of folic acid (FA) co-administered with the SP among pregnant women in Ghana.

Materials and Methods: The study employed a mixed-methods design of sequential explanatory approach in Ghana's urban and rural districts. A multi-stage sampling technique was used to recruit 3rd-trimester pregnant women (n=740) and 74 health service providers from 37 primary healthcare facilities with antenatal care (ANC) services. Obstetric and gynaecological characteristics, as well

as IPTp-SP history, were retrospectively assessed from the ANC records. In contrast, knowledge and personal characteristics were prospectively assessed. Quantitative data, including ITN data, was collected through a standard questionnaire from pregnant women and ANC service providers. Three focus group discussions (FGDs) were conducted in each district with pregnant women to collect information about the challenges in accessing and adhering to IPTp-SP and ITN interventions. The primary outcomes were the uptake of IPTp-SP during ANC visits and the co-administration of FA, and the regular use of ITNs. In addition, health system-related factors on the administration of SP and FA, as well as on ITN use, were assessed. Quantitative data for both the IPTp-SP and ITN interventions were first analysed through descriptive statistics, while the determinants of their uptake were analysed using Poisson and Binary logistic regressions, respectively. The qualitative data for IPTp-SP and ITNs were analysed using Microsoft Excel and QDA Miner Lite, respectively.

Results: Responses from 697 and 664 pregnant women were analysed for the IPTp-SP and ITNs interventions, respectively. Of these, 184 (26.4%) had taken the third dose of SP (SP3) in line with international guidelines. About 78% reported regular use of ITNs. IPTp-SP uptake was significantly associated with the number of maternal ANC visits and their gestational age at 1st ANC visit. In contrast, ITN use was associated with maternal knowledge of malaria in pregnancy, more ANC visits, gestational age at first ANC, and ownership of ITN. Most pregnant women were regularly co-administered SP together with 5 mg of FA, in contrast to the international recommendations of 0.4mg FA. The main challenge to IPTp-SP uptake was frequent drug stock out, which was confirmed both from the ANC providers and the pregnant women. Further challenges reported were provider negligence, adverse drug reactions, and mobile residency of pregnant women. Challenges related to the access and use of ITNs include sleep discomfort,

inability to mount the nets, poor knowledge of the importance of ITNs, and lack of motivation, among others.

***Conclusions and Recommendations*:** The uptake of IPTp-SP in the study area is deficient, partly explained by frequent drug stock-outs at health facilities. The high dosing of co-administered FA is against international recommendations. These observations need to be addressed urgently by the national public health authorities. Ownership of ITNs was comparably high among the pregnant women in the study area. However, regular use was still below the national and international targets. In both IPTp-SP and ITNs, health service providers need to formulate community and facility-level interventions that encourage early ANC bookings and regular attendance. There is also the need to focus on increasing specific maternal knowledge of malaria in pregnancy. The extent to which 5mg folic acid is co-administered with SP to pregnant women in Ghana and SSA and the exact motivation required by mothers to use ITNs, need to be further investigated.

5 ZUSAMMENFASSUNG

Hintergrund: Die Malariakrankheit ist in endemischen Ländern, insbesondere in Afrika südlich der Sahara (SSA), nach wie vor ein großes Problem der öffentlichen Gesundheit. Die Krankheit stellt ein großes Problem bei den an den stärksten gefährdeten Bevölkerungsgruppen der schwangeren Frauen und der Kinder unter fünf Jahren dar. Bestehende Interventionen wie die intermittierende vorbeugende Therapie in der Schwangerschaft (IPTp) mit Sulfadoxin-Pyrimethamin (SP) und die regelmäßige Verwendung von mit Insektiziden behandelten Bettnetzen (ITNs) sind sehr wirksam gegen Malariaerkrankungen, insbesondere gegen die Infektion der Plazenta. Eine große Herausforderung ist es, dass diese Interventionen bisher nur wenig in SSA implementiert sind, was zu erheblichen Malaria-bedingten Morbiditäten und Mortalitäten bei schwangeren Frauen und Säuglingen, sowie zu niedrigem Geburtsgewicht und Fehlgeburten führt. In dieser Studie wurden die persönlichen und gesundheitssystembezogenen Faktoren analysiert, die mit der IPTp-SP und der ITN Intervention bei schwangeren Frauen in Ghana einhergehen.

Zielsetzung: Die Studie wurde durchgeführt, um vier Hauptziele zu erreichen:

1. Schätzung der Verteilung der IPTp-SP-Annahme sowie des Besitzes und der Nutzung von ITNs bei schwangeren Frauen im städtischen und ländlichen Ghana.
2. Ermittlung der persönlichen und gesundheitlichen Faktoren, die die Annahme von IPTp-SP und ITN Interventionen bei schwangeren Frauen beeinflussen.
3. Messung des Wissens schwangerer Frauen über die Risiken von Malaria in der Schwangerschaft sowie des Wissens der ANC-Anbieter über die Umsetzung der SP-Richtlinienprotokolle in Ghana.
4. Beurteilung der Dosierung von Folsäure, die zusammen mit der SP bei schwangeren Frauen in Ghana verabreicht wird.

Materialien und Methoden: In der Studie wurde ein sequentiell erklärender Ansatz mit gemischten Methoden in den städtischen und ländlichen Gebieten Ghanas angewendet. Eine

mehrstufige Stichprobentechnik wurde verwendet, um schwangere Frauen im 3. Trimester (n = 740) und 74 Gesundheitsdienstleister aus 37 primären Gesundheitseinrichtungen mit vorgeburtlicher Versorgung (ANC) zu rekrutieren. Geburts- und gynäkologische Merkmale sowie die IPTp-SP-Vorgeschichte wurden retrospektiv aus den ANC-Aufzeichnungen bewertet, während Wissen und persönliche Merkmale prospektiv erfasst wurden. Quantitative Daten, auch zur ITN Intervention, wurden über einen Standardfragebogen von schwangeren Frauen und ANC-Dienstleistern gesammelt. In jedem Distrikt wurden drei Fokusgruppendiskussionen (FGDs) mit schwangeren Frauen durchgeführt, um Informationen über die Herausforderungen beim Zugang zu und der Einhaltung von IPTp-SP- und ITN-Interventionen zu sammeln. Die primären Ergebnisse waren die Aufnahme von IPTp-SP während der Schwangerschaftsvorsorge und die gleichzeitige Verabreichung von FA sowie die regelmäßige Anwendung von ITN. Darüber hinaus wurden die Faktoren des Gesundheitsdienstleisters und des Gesundheitssystems bei der Verwaltung von SP und FA sowie bei der Verwendung von ITN bewertet. Quantitative Daten sowohl für die IPTp-SP- als auch für die ITN-Interventionen wurden zuerst in deskriptiven Statistiken analysiert, während die Determinanten ihrer Annahme unter Verwendung von Poisson- bzw. binären logistischen Regressionen analysiert wurden. Die qualitativen Daten für IPTp-SP und ITNs wurden mit Microsoft Excel bzw. QDA Miner Lite analysiert.

Ergebnisse: Die Antworten von 697 und 664 schwangeren Frauen wurden auf die IPTp-SP- bzw. ITN-Interventionen analysiert. Von diesen hatten 184 (26,4%) die dritte Dosis SP (SP3) gemäß den internationalen Richtlinien eingenommen, während etwa 78% regelmäßig ihre ITNs verwendeten. Die IPTp-SP-Aufnahme war signifikant mit der Anzahl der ANC-Besuche bei Müttern und ihrem Gestationsalter beim ersten ANC-Besuch verbunden, während die Verwendung von ITNs stark mit dem Wissen der Mütter über Malaria in der Schwangerschaft, der

Anzahl der ANC-Besuche, dem Gestationsalter beim ersten ANC Besuch, und dem Besitz von ITNs assoziiert war. Den meisten schwangeren Frauen wurde im Gegensatz zu den internationalen Empfehlungen von 0,4 mg FA regelmäßig SP zusammen mit 5 mg FA verabreicht. Die Hauptherausforderung für die IPTp-SP-Aufnahme war die häufige Nichtverfügbarkeit von SP, was sowohl von den ANC-Anbietern als auch von den schwangeren Frauen bestätigt wurde. Weitere gemeldete Herausforderungen waren Nachlässigkeit des Gesundheitsarbeiter, unerwünschte Arzneimittelwirkungen und die Mobilität schwangerer Frauen. Zu den Herausforderungen im Zusammenhang mit dem Zugang und der Verwendung von ITNs zählen unter anderem Schlafstörungen, Unfähigkeit, die Netze zu montieren, mangelndes Wissen über die Bedeutung von ITNs und mangelnde Motivation.

Schlussfolgerungen und Empfehlungen: Die Annahme von IPTp-SP im Untersuchungsgebiet ist immer noch sehr gering, was teilweise durch häufige Nichtverfügbarkeit von Medikamenten in Gesundheitseinrichtungen erklärt wird. Die hohe Dosierung von gemeinsam mit SP verabreichtem FA widerspricht internationalen Empfehlungen. Diese Beobachtungen müssen von den nationalen Gesundheitsbehörden dringend angegangen werden. Der Besitz von ITNs ist bei schwangeren Frauen im Untersuchungsgebiet hoch, aber die regelmäßige Anwendung liegt immer noch unter den nationalen und internationalen Zielen. In beiden Fällen von IPTp-SP und ITNs sollten Gesundheitsdienstleister Interventionen auf Gemeinde- und Einrichtungsebene formulieren, die eine frühzeitige ANC-Buchung und regelmäßige Teilnahme fördern. Es besteht auch die Notwendigkeit, sich darauf zu konzentrieren, das Wissen der Mutter über Malaria in der Schwangerschaft zu verbessern. Die Problematik der gemeinsamen Verabreichung von 5 mg

Folsäure und SP bei schwangeren Frauen in Ghana und in SSA, sowie die genaue Motivation, die Mütter zur Verwendung von ITNs benötigen, müssen weiterhin untersucht werden.

6 BIBLIOGRAPHY

Abuaku, B., Ahorlu, C., Psychas, P., Ricks, P., Oppong, S., Mensah, S., Sackey, W., & Koram, K. A. (2018). Impact of indoor residual spraying on malaria parasitaemia in the Bunkpurugu-Yunyoo District in northern Ghana. *Parasites & Vectors*, *11*(1), 555. https://doi.org/10.1186/s13071-018-3130-z

Addai-Mensah, O., Annani-Akollor, M. E., Fondjo, L. A., Sarbeng, K., Anto, E. O., Owiredu, E. W., & Arthur, S. N. (2018). Regular antenatal attendance and education influence the uptake of intermittent preventive treatment of malaria in pregnancy: A cross-sectional study at the University Hospital, Kumasi, Ghana. *Journal of Tropical Medicine*. https://doi.org/10.1155/2018/5019215

Adebayo, A. M., Akinyemi, O. O., & Cadmus, E. O. (2014). Ownership and utilisation of insecticide-treated mosquito nets among caregivers of under-five children and pregnant women in a rural community in southwest Nigeria. *Journal of Preventive Medicine and Hygiene*, *55*(2), 58–64. https://doi.org/10.15167/2421-4248/jpmh2014.55.2.430

Afaya, A., Azongo, T. B., Dzomeku, V. M., Afaya, R. A., Salia, S. M., Adatara, P., Kaba Alhassan, R., Amponsah, A. K., Atakro, C. A., Adadem, D., Asiedu, E. O., Amuna, P., & Amogre Ayanore, M. (2020). Women's knowledge and its associated factors regarding optimum utilisation of antenatal care in rural Ghana: A cross-sectional study. *PLOS ONE*, *15*(7), e0234575. https://doi.org/10.1371/journal.pone.0234575

Ahmed, S. M., Hossain, S., Kabir, M. M., & Roy, S. (2011). Free distribution of insecticidal bed nets improves possession and preferential use by households and is equitable: findings from two cross-sectional surveys in thirteen malaria endemic districts of Bangladesh. *Malaria Journal*, *10*(1), 357. https://doi.org/10.1186/1475-2875-10-357

Alilio, M. S., Breman, J. G., & Mills, A. (2004). THE INTOLERABLE BURDEN OF MALARIA: WHAT'S NEW, WHAT'S NEEDED. *The American Journal of Tropical Medicine and Hygiene*, *71*(2_suppl), 0-0–i. https://doi.org/10.4269/ajtmh.2004.71.0

Alonso, P. L., Brown, G., Arevalo-Herrera, M., Binka, F., Chitnis, C., Collins, F., Doumbo, O. K., Greenwood, B., Hall, B. F., Levine, M. M., Mendis, K., Newman, R. D., Plowe, C. V., Rodríguez, M. H., Sinden, R., Slutsker, L., & Tanner, M. (2011). A Research Agenda to Underpin Malaria Eradication. *PLoS Medicine*, *8*(1), e1000406. https://doi.org/10.1371/journal.pmed.1000406

Aluko, J. O., Oluwatosin, A. O., Okwa, O., Natalie, C., Crookston, B., Dearden, K., Gray, B., Ivins, N., Alder, S., Davis, R., Yartey, J., Jimoh, A., Sofola, O., Petu, A., Okorosobo, T., Tako, E., Zhou, A., Lohoue, J., Leke, R., … Felema, B. (2012). Utilization of insecticide treated nets during pregnancy among postpartum women in Ibadan, Nigeria: a cross-sectional study. *BMC Pregnancy and Childbirth*, *12*(1), 21. https://doi.org/10.1186/1471-2393-12-21

Amankwah, S., & Anto, F. (2019). Factors Associated with Uptake of Intermittent Preventive Treatment of Malaria in Pregnancy: A Cross-Sectional Study in Private Health Facilities in Tema Metropolis, Ghana. *Journal of Tropical Medicine*, *2019*, 1–11.

https://doi.org/10.1155/2019/9278432

Ameh, S., Owoaje, E., Oyo-Ita, A., Kabiru, C. W., Akpet, O. E. O., Etokidem, A., Enembe, O., & Ekpenyong, N. (2016). Barriers to and determinants of the use of intermittent preventive treatment of malaria in pregnancy in Cross River State, Nigeria: a cross-sectional study. *BMC Pregnancy and Childbirth*, *16*(1), 99. https://doi.org/10.1186/s12884-016-0883-2

Ankomah, A., Adebayo, S. B., Arogundade, E. D., Anyanti, J., Nwokolo, E., Ladipo, O., & Meremikwu, M. M. (2012). Determinants of insecticide-treated net ownership and utilization among pregnant women in Nigeria. *BMC Public Health*, *12*(1), 105. https://doi.org/10.1186/1471-2458-12-105

Anto, F., Agongo, I. H., Asoala, V., Awini, E., & Oduro, A. R. (2019). Intermittent Preventive Treatment of Malaria in Pregnancy: Assessment of the Sulfadoxine-Pyrimethamine Three-Dose Policy on Birth Outcomes in Rural Northern Ghana. *Journal of Tropical Medicine*, *2019*. https://doi.org/10.1155/2019/6712685

Appiah, P. K., Bukari, M., Yiri-Erong, S. N., Owusu, K., Atanga, G. B., Nimirkpen, S., Kuubabongnaa, B. B., & Adjuik, M. (2020). Antenatal Care Attendance and Factors Influenced Birth Weight of Babies Born between June 2017 and May 2018 in the Wa East District, Ghana. *International Journal of Reproductive Medicine*, *2020*, 1–10. https://doi.org/10.1155/2020/1653076

Arrow, K. J., Panosian, C., & Gelband, H. (2004). Saving Lives, Buying Time: Economics of Malaria Drugs in an Age of Resistance. In U. D'Alessandro, S. Barrett, M. Daya, P. Heller, T. T. Hien, A. Keith, T. E. Taylor, T. K. Mutabingwa, F. Nosten, & J. D. Sachs (Eds.), *Institute of Medicine (US) Committee on the Economics of Antimalarial Drugs*. http://www.nap.edu/catalog/11017.html

Asah-Opoku, K., Ameme, D. K., Yawson, A., Guure, C. B., Mireku Aduama, D. E., Mumuni, K., Samba, A., & Maya, E. T. (2019). Adherence to the recommended timing of focused antenatal care in Accra, Ghana. *Pan African Medical Journal*, *33*, 1–15. https://doi.org/10.11604/pamj.2019.33.123.15535

Awine, T., Malm, K., Bart-Plange, C., & Silal, S. P. (2017). Towards malaria control and elimination in Ghana: challenges and decision making tools to guide planning. *Global Health Action*, *10*(1), 1381471. https://doi.org/10.1080/16549716.2017.1381471

Azizi, S. C. (2020). Uptake of intermittent preventive treatment for malaria during pregnancy with Sulphadoxine-Pyrimethamine in Malawi after adoption of updated World Health Organization policy: an analysis of demographic and health survey 2015–2016. *BMC Public Health*, *20*(1), 335. https://doi.org/10.1186/s12889-020-08471-5

Ba, D. M., Ssentongo, P., Kjerulff, K. H., Na, M., Liu, G., Gao, X., & Du, P. (2019). Adherence to Iron Supplementation in 22 Sub-Saharan African Countries and Associated Factors among Pregnant Women: A Large Population-Based Study. *Current Developments in Nutrition*, *3*(12), 1–8. https://doi.org/10.1093/cdn/nzz120

Bajaria, S., Festo, C., Mrema, S., Shabani, J., Hertzmark, E., & Abdul, R. (2019). Assessment of the impact of availability and readiness of malaria services on uptake of intermittent preventive treatment in pregnancy (IPTp) provided during ANC visits in Tanzania. *Malaria*

Journal, *18*(1), 229. https://doi.org/10.1186/s12936-019-2862-3

Beiersmann, C., De Allegri, M., Tiendrebéogo, J., Yé, M., Jahn, A., & Mueller, O. (2010). Different delivery mechanisms for insecticide-treated nets in rural Burkina Faso: a provider's perspective. *Malaria Journal*, *9*(1), 352. https://doi.org/10.1186/1475-2875-9-352

Birungi, H., Nyarko, P., Armar-Klemesu, M., Arhinful, D., Deganus, S., Odoi-Agyarko, H., & Brew, G. (2006). Acceptability and feasibility of introducing the WHO focused antenatal care package in Ghana. In *Population Council Frontiers in Reproductive Health* (Issue June). https://doi.org/10.31899/rh4.1147

Brieger, W. (2012). Control of malaria in pregnancy: an elusive target. *Africa Health*, *34*(January 2012), 15–18. http://www.africa-health.com/articles/january_2012/Malaria.pdf

Carter, J. Y., Loolpapit, M. P., Lema, O. E., Tome, J. L., Nagelkerke, N. J. D., & Watkins, W. M. (2005). Reduction of the efficacy of antifolate antimalarial therapy by folic acid supplementation. *American Journal of Tropical Medicine and Hygiene*, *73*(1), 166–170. https://doi.org/10.4269/ajtmh.2005.73.166

CDC. (2018). *Folic Acid | CDC*. National Center on Birth Defects and Developmental Disabilities. https://www.cdc.gov/ncbddd/folicacid/about.html

Chaponda, E. B., Chandramohan, D., Michelo, C., Mharakurwa, S., Chipeta, J., & Chico, R. M. (2015). High burden of malaria infection in pregnant women in a rural district of Zambia: a cross-sectional study. *Malaria Journal*, *14*(1), 380. https://doi.org/10.1186/s12936-015-0866-1

Chatio, S., Ansah, N. A., Awuni, D. A., Oduro, A., & Ansah, P. O. (2019). Community acceptability of Seasonal Malaria Chemoprevention of morbidity and mortality in young children: A qualitative study in the Upper West Region of Ghana. *PLOS ONE*, *14*(5), e0216486. https://doi.org/10.1371/journal.pone.0216486

Chepkemoi Ng'etich Mutulei, A. (2013). Factors Influencing the Uptake of Intermittent Preventive Treatment for Malaria in Pregnancy: Evidence from Bungoma East District, Kenya. *American Journal of Public Health Research*, *1*(5), 110–123. https://doi.org/10.12691/ajphr-1-5-2

Christophers, S. R. (1951). History of Malaria. *BMJ*, *1*(4711), 865–866. https://doi.org/10.1136/bmj.1.4711.865-a

City Population.de. (2020a). *Lambussie Karni (District, Ghana) - Population Statistics, Charts, Map and Location*. Lambussie-Karni District, Ghana. https://www.citypopulation.de/en/ghana/admin/upper_west/1008__lambussie_karni/

City Population.de. (2020b). *Upper West (Region, Ghana) - Population Statistics, Charts, Map and Location*. Upper West Region, Ghana. https://www.citypopulation.de/en/ghana/admin/10__upper_west/

City Population.de. (2020c). *Wa Municipal (Municipal District, Ghana) - Population Statistics, Charts, Map and Location*. Wa Municipal, Ghana. https://www.citypopulation.de/en/ghana/admin/upper_west/1002__wa_municipal/

Cox, F. E. (2010). History of the discovery of the malaria parasites and their vectors. *Parasites & Vectors*, *3*(1), 5. https://doi.org/10.1186/1756-3305-3-5

Cramer, J. P. (2015). Plasmodium knowlesi malaria: Overview Focussing on Travel-Associated Infections. *Current Infectious Disease Reports*, *17*(3), 8. https://doi.org/10.1007/s11908-015-0469-6

Creswell, J., & Clark, V. P. (2007). Ch. 3. Choosing a mixed methods design. In *Designing and conducting mixed methods research* (pp. 53–106). https://doi.org/1412927927

Cunningham, & Gary, F. (2014). Williams Obstetrics 24/E. In *Williams: obstetrica (23a. ed.)* (24th ed., Issue May, pp. 21–35). McGraw-Hill professional. https://d1wqtxts1xzle7.cloudfront.net/56041196/Medical_May.pdf?1520923643=&response-content-disposition=inline%3B+filename%3DWilliams_Obstetrics_24_E.pdf&Expires=1600183942&Signature=K14u8nTYE-QE2-KRqaYi0modnRCqcMFuxsAoV3C~cgymDvKqRUt28tl2wUXtmA3TT5~rRCi3

De-Regil, L. M., Peña-Rosas, J. P., Fernández-Gaxiola, A. C., & Rayco-Solon, P. (2015). Effects and safety of periconceptional oral folate supplementation for preventing birth defects. *Cochrane Database of Systematic Reviews*, *14*(January). https://doi.org/10.1002/14651858.CD007950.pub3

Desai, M., Hill, J., Fernandes, S., Walker, P., Pell, C., Gutman, J., Kayentao, K., Gonzalez, R., Webster, J., Greenwood, B., Cot, M., & ter Kuile, F. O. (2018). Prevention of malaria in pregnancy. *The Lancet Infectious Diseases*, *18*(4), e119–e132. https://doi.org/10.1016/S1473-3099(18)30064-1

Desai, M., ter Kuile, F. O., Nosten, F., McGready, R., Asamoa, K., Brabin, B., & Newman, R. D. (2007). Epidemiology and burden of malaria in pregnancy. *The Lancet Infectious Diseases*, *7*(2), 93–104. https://doi.org/10.1016/S1473-3099(07)70021-X

Dosoo, D. K., Chandramohan, D., Atibilla, D., Oppong, F. B., Ankrah, L., Kayan, K., Agyemang, V., Adu-Gyasi, D., Twumasi, M., Amenga-Etego, S., Bruce, J., Asante, K. P., Greenwood, B., & Owusu-Agyei, S. (2020). Epidemiology of malaria among pregnant women during their first antenatal clinic visit in the middle belt of Ghana: a cross sectional study. *Malaria Journal*, *19*(1), 381. https://doi.org/10.1186/s12936-020-03457-5

Dowswell, T., Carroli, G., Duley, L., Gates, S., Gülmezoglu, A. M., Khan-Neelofur, D., & Piaggio, G. (2015). Alternative versus standard packages of antenatal care for low-risk pregnancy. *Cochrane Database of Systematic Reviews*, *2015*(7), CD000934. https://doi.org/10.1002/14651858.CD000934.pub3

Eeuwijk, P. Van, & Angehrn, Z. (2017). *How to Conduct a Focus Group Discussion (FGD) Methodological Manual* (Issue April). https://www.swisstph.ch/fileadmin/user_upload/SwissTPH/Topics/Society_and_Health/Focus_Group_Discussion_Manual_van_Eeuwijk_Angehrn_Swiss_TPH_2017_2.pdf

Eisele, T. P., Keating, J., Littrell, M., Larsen, D., & Macintyre, K. (2009). Assessment of insecticide-treated bednet use among children and pregnant women across 15 countries using standardized national surveys. *The American Journal of Tropical Medicine and*

Hygiene, *80*(2), 209–214. http://www.ncbi.nlm.nih.gov/pubmed/19190215

Ezire, O., Adebayo, S., Idogho, O., Bamgboye, E., & Nwokolo, E. (2015). Determinants of use of insecticide-treated nets among pregnant women in Nigeria. *International Journal of Women's Health*, *7*, 655. https://doi.org/10.2147/IJWH.S77807

Feachem, R. G., Phillips, A. A., Targett, G. A., & Snow, R. W. (2010). Call to action: priorities for malaria elimination. *The Lancet*, *376*(9752), 1517–1521. https://doi.org/10.1016/S0140-6736(10)61500-0

Feng, G., Simpson, J. A., Chaluluka, E., Molyneux, M. E., & Rogerson, S. J. (2010). Decreasing Burden of Malaria in Pregnancy in Malawian Women and Its Relationship to Use of Intermittent Preventive Therapy or Bed Nets. *PLoS ONE*, *5*(8), e12012. https://doi.org/10.1371/journal.pone.0012012

Fuge, T. G., Ayanto, S. Y., & Gurmamo, F. L. (2015). Assessment of knowledge, attitude and practice about malaria and ITNs utilization among pregnant women in Shashogo District, Southern Ethiopia. *Malaria Journal*, *14*(1), 235. https://doi.org/10.1186/s12936-015-0755-7

Gamble, C. L., Ekwaru, J. P., & ter Kuile, F. O. (2006). Insecticide-treated nets for preventing malaria in pregnancy. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD003755.pub2

Gari, T., & Lindtjørn, B. (2018). Reshaping the vector control strategy for malaria elimination in Ethiopia in the context of current evidence and new tools: Opportunities and challenges 11 Medical and Health Sciences 1108 Medical Microbiology 11 Medical and Health Sciences 1117 Public He. In *Malaria Journal* (Vol. 17, Issue 1, p. 454). BioMed Central Ltd. https://doi.org/10.1186/s12936-018-2607-8

Ghana Demographic Health Survey. (2015). *Ghana Demographic Health Survey (GDHS) 2014 - Key Indicators*.

Ghana Health Service. (2015). *The Health System in Ghana, facts and Figures*. internal-pdf://0240438844/Facts-and-figures-2015_GHS.pdf%0Ahttp://www.moh.gov.gh/wp-content/uploads/2017/07/Facts-and-figures-2015.pdf

Ghana Health Service. (2016). *National Malaria Control Program*. http://www.ghanahealthservice.org/downloads/2016 -Annual_Bulletin.pdf

Ghana Statistical Service-DHS. (2009). Ghana Demographic and Health Survey 2008. In *Ghana Statistical Service (GSS) Ghana Demographic and Health Survey*.

Ghana Statistical Service. (2013). *2010 Population & Housing Census: Regional Analytical Report - Upper West Region*.

Ghana Statistical Service. (2014). *Population Projections/Prospects*. http://www.statsghana.gov.gh/docfiles/2010phc/Mono/Ghana Population Prospects.pdf

Ghana Statistical Service. (2017). *Key Malaria indicators from the 2016 Ghana Malaria Indicator Survey*. http://www.statsghana.gov.gh/docfiles/publications/Ghana MIS 2016 KIR - 06March2017.pdf

Ghana Statistical Service. (2020). *Ghana Malaria Indicator Survey 2019 Final Report*. www.DHSprogram.com.

GHS_UWR. (2017). *Upper West Regional Health Services 2016 Annual Report*. https://www.ghanahealthservice.org/downloads/2016_UWR_Annual_Report.pdf

GHS_UWR. (2020). *Ghana Health Service Upper West Regional Health Directorate 2019 Annual Report* (Issue July).

GHS-NMCP. (2016). *Ghana Malaria Control Programme Periodic Bulletin*. http://www.ghanahealthservice.org/downloads/2016 -Annual_Bulletin.pdf

GHS-NMCP. (2020). National Malaria Control Programme Annual report. *Ghana Health Service*, *8*, 1–15. http://www.ghanahealthservice.org/downloads/2016 -Annual_Bulletin.pdf

Gleave, K., Lissenden, N., Richardson, M., Choi, L., & Ranson, H. (2018). Piperonyl butoxide (PBO) combined with pyrethroids in insecticide-treated nets to prevent malaria in Africa. *Cochrane Database of Systematic Reviews*, *2018*(11). https://doi.org/10.1002/14651858.CD012776.pub2

Gogue, C., Wagman, J., Tynuv, K., Saibu, A., Yihdego, Y., Malm, K., Mohamed, W., Akplu, W., Tagoe, T., Ofosu, A., Williams, I., Asiedu, S., Richardson, J., Fornadel, C., Slutsker, L., & Robertson, M. (2020). An observational analysis of the impact of indoor residual spraying in Northern, Upper East, and Upper West Regions of Ghana: 2014 through 2017. *Malaria Journal*, *19*(1), 242. https://doi.org/10.1186/s12936-020-03318-1

Gruell, H., Hamacher, L., Jennissen, V., Tuchscherer, A., Ostendorf, N., Löffler, T., Hallek, M., Kochanek, M., Tannich, E., Böll, B., & Fätkenheuer, G. (2017). On Taking a Different Route: An Unlikely Case of Malaria by Nosocomial Transmission. *Clinical Infectious Diseases*, *65*(8), 1404–1406. https://doi.org/10.1093/cid/cix520

Gutman, J. R., Stephens, D. K., Tiendrebeogo, J., Badolo, O., Dodo, M., Burke, D., Williamson, J., Vibbert, K., Youll, S. J., Savadogo, Y., & Brieger, W. R. (2020). A cluster randomized trial of delivery of intermittent preventive treatment of malaria in pregnancy at the community level in Burkina Faso. *Malaria Journal*, *19*(1), 1–11. https://doi.org/10.1186/s12936-020-03356-9

Hill, J., Hoyt, J., van Eijk, A. M., D'Mello-Guyett, L., ter Kuile, F. O., Steketee, R., Smith, H., & Webster, J. (2013). Factors Affecting the Delivery, Access, and Use of Interventions to Prevent Malaria in Pregnancy in Sub-Saharan Africa: A Systematic Review and Meta-Analysis. *PLoS Medicine*, *10*(7). https://doi.org/10.1371/journal.pmed.1001488

Hill, J., Hoyt, J., van Eijk, A. M., ter Kuile, F. O., Webster, J., & Steketee, R. W. (2014). Prioritizing Pregnant Women for Long-Lasting Insecticide Treated Nets through Antenatal Care Clinics. *PLoS Medicine*, *11*(9), e1001717. https://doi.org/10.1371/journal.pmed.1001717

Ibrahim, H., Maya, E. T., Issah, K., Apanga, P. A., Bachan, E. G., & Noora, C. L. (2017). Factors influencing uptake of intermittent preventive treatment of malaria in pregnancy using sulphadoxine pyrimethamine in sunyani municipality, Ghana. *Pan African Medical Journal*, *28*. https://doi.org/10.11604/pamj.2017.28.122.12611

Ishtiaq, M. (2019a). Book Review Creswell, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.). Thousand Oaks, CA: Sage. *English Language Teaching*, *12*(5), 40. https://doi.org/10.5539/elt.v12n5p40

Ishtiaq, M. (2019b). Book Review Creswell, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.). Thousand Oaks, CA: Sage. *English Language Teaching*, *12*(5), 40. https://doi.org/10.5539/elt.v12n5p40

Kanmiki, E. W., Awoonor-Williams, J. K., Phillips, J. F., Kachur, S. P., Achana, S. F., Akazili, J., & Bawah, A. A. (2019). Socio-economic and demographic disparities in ownership and use of insecticide-treated bed nets for preventing malaria among rural reproductive-aged women in northern Ghana. *PLOS ONE*, *14*(1), e0211365. https://doi.org/10.1371/journal.pone.0211365

Kanté, A. M., Nathan, R., Helleringer, S., Sigilbert, M., Levira, F., Masanja, H., de Savigny, D., Abdulla, S., & Phillips, J. F. (2014). The contribution of reduction in malaria as a cause of rapid decline of under-five mortality: evidence from the Rufiji Health and Demographic Surveillance System (HDSS) in rural Tanzania. *Malaria Journal*, *13*(1), 180. https://doi.org/10.1186/1475-2875-13-180

Kantele, A., & Jokiranta, T. S. (2011). Review of Cases With the Emerging Fifth Human Malaria Parasite, Plasmodium knowlesi. *Clinical Infectious Diseases*, *52*(11), 1356–1362. https://doi.org/10.1093/cid/cir180

Karunamoorthi, K. (2011). Vector control: A cornerstone in the malaria elimination campaign. In *Clinical Microbiology and Infection* (Vol. 17, Issue 11, pp. 1608–1616). Blackwell Publishing Ltd. https://doi.org/10.1111/j.1469-0691.2011.03664.x

Kearns, A., Hurst, T., Caglia, J., & Langer, A. (2014). *Focused Antenatal Care in Tanzania: Delivering individualised, targeted, high-quality care* (August; 2014). https://cdn2.sph.harvard.edu/wp-content/uploads/sites/32/2014/09/HSPH-Tanzania5.pdf

Khanam, F., Hossain, M. B., Chowdhury, T. R., Rahman, M. S., Kabir, M., Naher, S., Islam, M. A., & Rahman, M. (2018). Exploring the gap between coverage, access, and utilization of long-lasting insecticide-treated nets (LLINs) among the households of malaria endemic districts in Bangladesh. *Malaria Journal*, *17*(1), 455. https://doi.org/10.1186/s12936-018-2610-0

Killeen, G. F., Tatarsky, A., Diabate, A., Chaccour, C. J., Marshall, J. M., Okumu, F. O., Brunner, S., Newby, G., Williams, Y. A., Malone, D., Tusting, L. S., & Gosling, R. D. (2017). Developing an expanded vector control toolbox for malaria elimination. *BMJ Global Health*, *2*(2), 211. https://doi.org/10.1136/bmjgh-2016-000211

Koenker, H., Arnold, F., Ba, F., Cisse, M., Diouf, L., Eckert, E., Erskine, M., Florey, L., Fotheringham, M., Gerberg, L., Lengeler, C., Lynch, M., Mnzava, A., Nasr, S., Ndiop, M., Poyer, S., Renshaw, M., Shargie, E., Taylor, C., … Kilian, A. (2018). Assessing whether universal coverage with insecticide-treated nets has been achieved: is the right indicator being used? *Malaria Journal*, *17*(1), 355. https://doi.org/10.1186/s12936-018-2505-0

Korenromp, E. L., Miller, J., Cibulskis, R. E., Kabir Cham, M., Alnwick, D., & Dye, C. (2003). Monitoring mosquito net coverage for malaria control in Africa: possession vs. use by

children under 5 years. *Tropical Medicine and International Health*, *8*(8), 693–703. https://doi.org/10.1046/j.1365-3156.2003.01084.x

Kruger, A. R., & Casey, M. A. (2000). *Focus groups: A Practical Guide for Applied Research* (3rd ed.). Thousand Oaks, CA. Sage Publications, Inc. https://cms.bsu.edu/-/media/WWW/DepartmentalContent/Effectiveness/pdfs/LendingLibrary/Focus Groups.pdf

Kuusaana, E. D., & Eledi, J. A. (2015). Customary land allocation, urbanization and land use planning in Ghana: Implications for food systems in the Wa Municipality. *Land Use Policy*, *48*(November 2015), 454–466. https://doi.org/10.1016/j.landusepol.2015.06.030

Kweku, M., Webster, J., Taylor, I., Burns, S., Dedzo, M., Bryce, J., Arifeen, S. el, Pariyo, G., Lanata, C., Gwatkin, D., Habicht, J., Worrall, E., Hill, J., Webster, J., Mortimer, J., Guyatt, H., Gotink, M., Ochola, S., Snow, R., … Grabowsky, M. (2007). Public-private delivery of insecticide-treated nets: a voucher scheme in Volta Region, Ghana. *Malaria Journal*, *6*(1), 14. https://doi.org/10.1186/1475-2875-6-14

Lungu, F., Malata, A., Chirwa, E., & Mbendera, I. (2011). Quality assessment of focused antenatal care services in Malawi. *African Journal of Midwifery and Women's Health*, *5*(4), 169–175. https://doi.org/10.12968/ajmw.2011.5.4.169

Mace, K. E., Arguin, P. M., Lucchi, N. W., & Tan, K. R. (2019). Malaria Surveillance — United States, 2016. *MMWR. Surveillance Summaries*, *68*(5), 1–35. https://doi.org/10.15585/mmwr.ss6805a1

Manu, G., Boamah-Kaali, E. A., Febir, L. G., Ayipah, E., Owusu-Agyei, S., & Asante, K. P. (2017a). Low Utilization of Insecticide-Treated Bed Net among Pregnant Women in the Middle Belt of Ghana. *Malaria Research and Treatment*, *2017*, 1–7. https://doi.org/10.1155/2017/7481210

Manu, G., Boamah-Kaali, E. A., Febir, L. G., Ayipah, E., Owusu-Agyei, S., & Asante, K. P. (2017b). Low Utilization of Insecticide-Treated Bed Net among Pregnant Women in the Middle Belt of Ghana. *Malaria Research and Treatment*, *2017*, 1–7. https://doi.org/10.1155/2017/7481210

Marchant, T., Nathan, R., Jones, C., Mponda, H., Bruce, J., Sedekia, Y., Schellenberg, J., Mshinda, H., & Hanson, K. (2008). Individual, facility and policy level influences on national coverage estimates for intermittent preventive treatment of malaria in pregnancy in Tanzania. *Malaria Journal*, *7*(1), 260. https://doi.org/10.1186/1475-2875-7-260

Marin, M. C., & Baume, C. A. (2007). Intra-household Mosquito Net Use in Ethiopia, Ghana, Mali, Nigeria, Senegal, and Zambia: Are Nets Being Used? Who in the Household Uses Them? *The American Journal of Tropical Medicine and Hygiene*, *77*(5), 963–971. https://doi.org/10.4269/ajtmh.2007.77.963

Mbuagbaw, L., Habiba Garga, K., & Ongolo-Zogo, P. (2014). Health system and community level interventions for improving antenatal care coverage and health outcomes. In L. Mbuagbaw (Ed.), *Cochrane Database of Systematic Reviews* (Vol. 2014, Issue 2). John Wiley & Sons, Ltd. https://doi.org/10.1002/14651858.CD010994

Mchenga, M., Burger, R., & von Fintel, D. (2019). Examining the impact of WHO's Focused

Antenatal Care policy on early access, underutilisation and quality of antenatal care services in Malawi: a retrospective study. *BMC Health Services Research*, *19*(1), 295. https://doi.org/10.1186/s12913-019-4130-1

MDG Wiki Handbook. (2012). *MDG 5.5 Antenatal care coverage (at least one visit and at least four visits) - ScrewTurn Wiki*. http://mdgs.un.org/unsd/mi/wiki/5-5-Antenatal-care-coverage-at-least-one-visit-and-at-least-four-visits.ashx

Medicines for Malaria Venture. (2017). *Ghana | Burden of Malaria*. Severe Malaria Observatory. https://www.severemalaria.org/countries/ghana%0Ahttps://www.severemalaria.org/countries/ghana%0Ahttps://www.severemalaria.org/countries/ghana#&gid=4&pid=1%0Ahttps://www.severemalaria.org/countries/ghana

Ministry of Local Government. (2020). *Ghana Districts: A repository of all Local Assemblies in Ghana*. Ghana Districts Home. https://www.ghanadistricts.com/Home/District/168

Morgan, L. D. (1996). Focus Groups. *Annual Review of Sociology*, *22*, 129–152. https://doi.org/10.1146/annurev.soc.22.1.129

Müller, O. (2011). *Malaria in Africa: Challenges for Control and Elimination in the 21 st Century (Challenges in Public Health)* (O. Razum (ed.); 1st ed.).

Müller, O., De Allegri, M., Becher, H., Tiendrebogo, J., Beiersmann, C., Ye, M., Kouyate, B., Sie, A., & Jahn, A. (2008). Distribution systems of insecticide-treated bed nets for malaria control in rural Burkina Faso: cluster-randomized controlled trial. *PloS One*, *3*(9), e3182. https://doi.org/10.1371/journal.pone.0003182

National Health Insurance Scheme. (2020). *NATIONAL HEALTH INSURANCE SCHEME MEDICINES LIST FOR LEVEL ' C ' FACILITIES (DISTRICT HOSPITAL)* (C, Issue April).

National Malaria Control Programme. (2015). *2015 Half Year Bulletin - National Malaria Control Surveillance Bulletin* (Issue 2). http://www.ghanahealthservice.org/downloads/2015 Half Year Bulletin.pdf

National Malaria Control Programme. (2016). MALARIA 1ST QUARTER BULLETIN - 2016: NATIONAL MALARIA CONTROL SURVEILLANCE BULLETIN – ISSUE 5. In *Ghana Health Service* (Issue-5). Ghana Health Service. http://www.ghanahealthservice.org/downloads/1st Quarter Malaria Bulletin - 2016_14th July 2016.pdf

Nonvignon, J., Aryeetey, G. C., Issah, S., Ansah, P., Malm, K. L., Ofosu, W., Tagoe, T., Agyemang, S. A., & Aikins, M. (2016). Cost-effectiveness of seasonal malaria chemoprevention in upper west region of Ghana. *Malaria Journal*, *15*(1), 367. https://doi.org/10.1186/s12936-016-1418-z

Noor, A. M., Mutheu, J. J., Tatem, A. J., Hay, S. I., & Snow, R. W. (2009). Insecticide-treated net coverage in Africa: mapping progress in 2000–07. *The Lancet*, *373*(9657), 58–67. https://doi.org/10.1016/S0140-6736(08)61596-2

Obol, J., David Lagoro, K., & Christopher Garimoi, O. (2011). Knowledge and Misconceptions

about Malaria among Pregnant Women in a Post-Conflict Internally Displaced Persons' Camps in Gulu District, Northern Uganda. *Malaria Research and Treatment*, *2011*, 1–7. https://doi.org/10.4061/2011/107987

Odjidja, E. N., Kwanin, C., & Saha, M. (2017). Low Uptake of Intermittent Preventive Treatment in Ghana; An Examination of Health System Bottlenecks. *Health Systems and Policy Research*, *4*(3). https://doi.org/10.21767/2254-9137.100079

Oduro, A. R., Fryauff, D. J., Koram, K. A., Rogers, W. O., Anto, F., Atuguba, F., Anyorigiya, T., Adjuik, M., Ansah, P., Hodgson, A., & Nkrumah, F. (2010). Sulfadoxine-pyrimethamine-based intermittent preventive treatment, bed net use, and antenatal care during pregnancy: demographic trends and impact on the health of newborns in the Kassena Nankana District, northeastern Ghana. *The American Journal of Tropical Medicine and Hygiene*, *83*(1), 79–89. https://doi.org/10.4269/ajtmh.2010.10-0066

Oladimeji, K. E., Tsoka-Gwegweni, J. M., Ojewole, E., & Yunga, S. T. (2019). Knowledge of malaria prevention among pregnant women and non-pregnant mothers of children aged under 5 years in Ibadan, South West Nigeria. *Malaria Journal*, *18*(1), 92. https://doi.org/10.1186/s12936-019-2706-1

Onyebuchi, A. K., Lawani, L. O., Iyoke, C. A., Onoh, C. R., & Okeke, N. E. (2014). Adherence to intermittent preventive treatment for malaria with sulphadoxine-pyrimethamine and outcome of pregnancy among parturients in South East Nigeria. *Patient Preference and Adherence*, *8*, 447–452. https://doi.org/10.2147/PPA.S61448

Oppong, F. B., Gyaase, S., Zandoh, C., Nettey, O. E. A., Amenga-Etego, S., Anane, E. A., Adda, R., Dosoo, D. K., Owusu-Agyei, S., & Asante, K. P. (2019). Intermittent preventive treatment of pregnant women in Kintampo area of Ghana with sulphadoxine-pyrimethamine (SP): Trends spanning 2011 and 2015. *BMJ Open*, *9*(6). https://doi.org/10.1136/bmjopen-2018-027946

Oresanya, O. B., Hoshen, M., & Sofola, O. T. (2008). Utilization of insecticide-treated nets by under-five children in Nigeria: Assessing progress towards the Abuja targets. *Malaria Journal*, *7*(1), 145. https://doi.org/10.1186/1475-2875-7-145

Organização Mundial da Saúde. (2019). Guidelines for Malaria Vector Control. In *Guidelines for Malaria Vector Control*. http://www.ncbi.nlm.nih.gov/pubmed/30844152

Oshinyemi T., E., Aluko J., O., & Oluwatosin O., A. (2018). Focused antenatal care: Re-appraisal of current practices. *International Journal of Nursing and Midwifery*, *10*(8), 90–98. https://doi.org/10.5897/IJNM2018.0312

Oteng-Ababio, M., Owusu, G., & Asafo, D. M. (2019). Following the footsteps: Urbanisation of Wa Municipality and its synergism in risk accumulation, uncertainties and complexities in urban Ghana. *Jàmbá: Journal of Disaster Risk Studies*, *11*(1), 1–10. https://doi.org/10.4102/jamba.v11i1.479

Owusu-Ofori, A. K., Betson, M., Parry, C. M., Stothard, J. R., & Bates, I. (2013). Transfusion-Transmitted Malaria in Ghana. *Clinical Infectious Diseases*, *56*(12), 1735–1741. https://doi.org/10.1093/cid/cit130

Peters, P. J., Thigpen, M. C., Parise, M. E., & Newman, R. D. (2007). Safety and toxicity of sulfadoxine/pyrimethamine: Implications for malaria prevention in pregnancy using intermittent preventive treatment. *Drug Safety*, *30*(6), 481–501. https://doi.org/10.2165/00002018-200730060-00003

PMI-AIRS Ghana. (2017). *AIRS Ghana IRS Results*. http://www.africairs.net/where-we-work/ghana/

Population Reference Bureau. (2001). *Malaria Continues to Threaten Pregnant Women and Children*. POPULATION REFERENCE BUREAU. https://www.prb.org/malariacontinuestothreatenpregnantwomenandchildren/#

Raghavendra, K., Barik, T. K., Reddy, B. P. N., Sharma, P., & Dash, A. P. (2011). Malaria vector control: From past to future. *Parasitology Research*, *108*(4), 757–779. https://doi.org/10.1007/s00436-010-2232-0

Rassi, C., Graham, K., King, R., Ssekitooleko, J., Mufubenga, P., & Gudoi, S. S. (2016). Assessing demand-side barriers to uptake of intermittent preventive treatment for malaria in pregnancy: a qualitative study in two regions of Uganda. *Malaria Journal*, *15*(1), 1–14. https://doi.org/10.1186/s12936-016-1589-7

Rogerson, S. J. (2017). Management of malaria in pregnancy. *The Indian Journal of Medical Research*, *146*(3), 328–333. https://doi.org/10.4103/ijmr.IJMR_1304_17

Rogerson, S. J., & Meshnick, S. (2019). Malaria in Pregnancy: Late Consequences of Early Infections. *The Journal of Infectious Diseases*, *220*(9), 1396–1398. https://doi.org/10.1093/infdis/jiy738

Samba, E. M. (1997). The burden of malaria in Africa. *Africa Health*, *19*(2), 17. http://www.ncbi.nlm.nih.gov/pubmed/12292299

Sangaré, L. R., Weiss, N. S., Brentlinger, P. E., Richardson, B. A., Staedke, S. G., Kiwuwa, M. S., Stergachis, A., Menendez, C., Desai, M., Kuile, F. ter, Nosten, F., McGready, R., Asamoa, K., Greenwood, B., Alonso, P., Kuile, F. ter, Hill, J., Steketee, R., Menendez, C., … Rowland, M. (2012). Determinants of Use of Insecticide Treated Nets for the Prevention of Malaria in Pregnancy: Jinja, Uganda. *PLoS ONE*, *7*(6), e39712. https://doi.org/10.1371/journal.pone.0039712

Schantz-Dunn, J., & Nour, N. M. (2009). Malaria and pregnancy: a global health perspective. *Reviews in Obstetrics & Gynecology*, *2*(3), 186–192. http://www.ncbi.nlm.nih.gov/pubmed/19826576

Shretta, R., Silal, S. P., Malm, K., Mohammed, W., Narh, J., Piccinini, D., Bertram, K., Rockwood, J., & Lynch, M. (2020). Estimating the risk of declining funding for malaria in Ghana: The case for continued investment in the malaria response. *Malaria Journal*, *19*(1), 196. https://doi.org/10.1186/s12936-020-03267-9

Shulman, C. E., Dorman, E. K., Cutts, F., Kawuondo, K., Bulmer, J. N., Peshu, N., & Marsh, K. (1999). Intermittent sulphadoxine-pyrimethamine to prevent severe anaemia secondary to malaria in pregnancy: a randomised placebo-controlled trial. *Lancet (London, England)*, *353*(9153), 632–636. https://doi.org/10.1016/s0140-6736(98)07318-8

Singh, M., Brown, G., & Rogerson, S. J. (2013). Ownership and use of insecticide-treated nets during pregnancy in sub-Saharan Africa: a review. *Malaria Journal*, *12*(1), 268. https://doi.org/10.1186/1475-2875-12-268

SPRING-USAID. (2017). *Case Management of Malaria | SPRING*. SPRING - Understanding Anemia. https://www.spring-nutrition.org/publications/series/understanding-anemia/options/case-management-malaria

Steketee, R. W., Nahlen, B. L., Parise, M. E., & Menendez., C. (2001). The Burden of Malaria in Pregnancy in Malaria-Endemic Areas. *American Journal of Tropical Medicine and Hygiene.*, *64*(1). https://www.ncbi.nlm.nih.gov/books/NBK2623/#pg28.r1

Sullivan, D. (2006). *Malariology Overview* (pp. 1–34). The Johns Hopkins University. http://ocw.jhsph.edu/courses/malariology/PDFs/lecture1.pdf

Suuron, V. M., Mwanri, L., Tsourtos, G., & Owusu-Addo, E. (2020). An exploratory study of the acceptability of indoor residual spraying for malaria control in upper western Ghana. *BMC Public Health*, *20*(1), 465. https://doi.org/10.1186/s12889-020-08505-y

Tegegne, Y., Asmelash, D., Ambachew, S., Eshetie, S., Addisu, A., & Jejaw Zeleke, A. (2019). The Prevalence of Malaria among Pregnant Women in Ethiopia: A Systematic Review and Meta-Analysis. *Journal of Parasitology Research*, *2019*, 1–9. https://doi.org/10.1155/2019/8396091

Thiam, S., Kimotho, V., & Gatonga, P. (2013). Why are IPTp coverage targets so elusive in sub-Saharan Africa? A systematic review of health system barriers. *Malaria Journal*, *12*. https://doi.org/10.1186/1475-2875-12-353

Tseroni, M., Georgitsou, M., Baka, A., Pinaka, O., Pervanidou, D., Tsironi, M., Bleta, P., Charvalakou, M., Psinaki, I., Dionysopoulou, M., Legaki, A., Vakali, A., Patsoula, E., Vassalou, E., Bellou, S., Diamantopoulos, V., Georgakopoulou, T., Mouchtouri, V., Tsiodras, S., … Hadjichristodoulou, C. (2020). The importance of an active case detection (Acd) programme for malaria among migrants from malaria endemic countries: The greek experience in a receptive and vulnerable area. *International Journal of Environmental Research and Public Health*, *17*(11), 1–16. https://doi.org/10.3390/ijerph17114080

UNAIDS/WHO. (2010). *Global report: UNAIDS report on the global AIDS Epidemic 2010* (UNAIDS/10.11E (JC1958E); Joint United Nations Programme on HIV/AIDS 2010). https://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2010/20101123_globalreport_en%5B1%5D.pdf

USAID-PMI. (2016). *President's Malaria Initiative: Ghana Malaria Operational Plan FY 2016*. https://www.pmi.gov/docs/default-source/default-document-library/malaria-operational-plans/fy16/fy-2016-ghana-malaria-operational-plan.pdf?sfvrsn=5

USAID-PMI. (2020). *FY 2020 Ghana Malaria Operational Plan*. www.pmi.gov

van Damme, W. (2004). Malaria Control during Mass Population Movements and Natural Disasters. *Journal of Refugee Studies*, *17*(1), 145–146. https://doi.org/10.1093/jrs/17.1.145

van Eijk, A. M., Hill, J., Alegana, V. A., Kirui, V., Gething, P. W., ter Kuile, F. O., Snow, R. W., Desai, M., Kuile, F. ter, Nosten, F., al., et, Dellicour, S., Tatem, A., Guerra, C., Snow, R.,

Kuile, F. ter, WHO, Kuile, F. ter, Eijk, A. van, … Nations, U. (2011). Coverage of malaria protection in pregnant women in sub-Saharan Africa: a synthesis and analysis of national survey data. *The Lancet. Infectious Diseases*, *11*(3), 190–207. https://doi.org/10.1016/S1473-3099(10)70295-4

Villar, J., Ba'aqeel, H., Piaggio, G., Lumbiganon, P., Belizán, J. M., Farnot, U., Al-Mazrou, Y., Carroli, G., Pinol, A., Donner, A., Langer, A., Nigenda, G., Mugford, M., Fox-Rushby, J., Hutton, G., Bergsjø, P., Bakketeig, L., & Berendes, H. (2001a). WHO antenatal care randomised trial for the evaluation of a new model of routine antenatal care. *The Lancet*, *357*(9268), 1551–1564. https://doi.org/10.1016/S0140-6736(00)04722-X

Villar, J., Ba'aqeel, H., Piaggio, G., Lumbiganon, P., Belizán, J. M., Farnot, U., Al-Mazrou, Y., Carroli, G., Pinol, A., Donner, A., Langer, A., Nigenda, G., Mugford, M., Fox-Rushby, J., Hutton, G., Bergsjø, P., Bakketeig, L., & Berendes, H. (2001b). WHO antenatal care randomised trial for the evaluation of a new model of routine antenatal care. *The Lancet*, *357*(9268), 1551–1564. https://doi.org/10.1016/S0140-6736(00)04722-X

Wang, D. (2000). *Confidence intervals for the ratio of two binomial proportions by Koopman's method. Stata Technical Bulletin 58: 16–19. Reprinted in Stata Technical Bulletin Reprints* (Issue 10 (58)). http://www.stata-press.com/data/r13/auto

White, N. J., Pukrittayakamee, S., Hien, T. T., Faiz, M. A., Mokuolu, O. A., & Dondorp, A. M. (2014). Malaria. *The Lancet*, *383*(9918), 723–735. https://doi.org/10.1016/S0140-6736(13)60024-0

WHO-Briefing Kit. (2020). *WORLD MALARIA REPORT: TOP-LINE MESSAGES*. https://www.who.int/docs/default-source/malaria/world-malaria-reports/world-malaria-report-2020-briefing-kit-eng.pdf?sfvrsn=eda98467_9

WHO-HTM-GMP. (2017). World Malaria Day 2017: Malaria Prevention Works, let's close the gap. In *WHO/HTM/GMP/2017.6* (Vol. 6). https://doi.org/CC BY-NC-SA 3.0 IGO

WHO/GMP. (2008). *WHO Global Malaria Programme: Position Statement on ITNs*. WHO. http://medi-guide.meditool.cn/ymtpdf/FBACA171-AF95-DCFA-673E-3FA3AFEB79AE.pdf

WHO. (2002). *WHO Programm to Map Best reproductive Health Practices* (WHO/RHR/01.30). https://apps.who.int/iris/bitstream/handle/10665/42513/WHO_RHR_01.30.pdf

WHO. (2009a). *Malaria case management: Operations manual*. https://apps.who.int/iris/bitstream/handle/10665/44124/9789241598088_eng.pdf?sequence=1

WHO. (2009b). WEEKLY IRON-FOLIC ACID SUPPLEMENTATION (WIFS) IN WOMEN OF REPRODUCTIVE AGE : ITS ROLE IN PROMOTING OPTIMAL MATERNAL AND CHILD HEALTH ThE WhO glOBal ExPERT cOnSUlTaTiOn WEEkly iROn and FOlic acid SUPPlEmEnTaTiOn cOnSUlTaTiOn REcOmmEndaTiOnS. In *Organization*. https://apps.who.int/iris/bitstream/handle/10665/89743/WHO_NMH_NHD_MNM_09.2_eng.pdf

WHO. (2012a). *Case management GUIDE FOR PARTICIPANTS TRAINING MODULE ON*

MALARIA CONTROL. www.who.int

WHO. (2012b). WHO Evidence Review Group: Intermittent Preventive Treatment of malaria in pregnancy (IPTp) with Sulfadoxine - Pyrimethamine (SP). In *Malaria Policy Advisory Committee Meeting* (Issue September). http://www.who.int/malaria/mpac/sep2012/iptp_sp_erg_meeting_report_july2012.pdf?ua=1

WHO. (2013). *WHO policy brief for the implementation of intermittent preventive treatment of malaria in pregnancy using sulfadoxine-pyrimethamine (IPTp-SP)* (WHO/HTM/GMP/2014.4; Revised January 2014). http://www.who.int/malaria/publications/atoz/iptp-sp-updated-policy-brief-24jan2014.pdf

WHO. (2014). *WHO policy brief for the implementation of intermittent preventive treatment of malaria in pregnancy using sulfadoxine-pyrimethamine (IPTp-SP)* (Revised January 2014). http://www.who.int/malaria/publications/atoz/iptp-sp-updated-policy-brief-24jan2014.pdf

WHO. (2015). Trends in Maternal Mortality: 1990 to 2015: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. In *Global Health Observatory*. https://www.who.int/data/gho/health-equity/report_2015

WHO. (2016a). *True magnitude of stillbirths and maternal and neonatal deaths underreported*. https://www.who.int/news/item/16-08-2016-true-magnitude-of-stillbirths-and-maternal-and-neonatal-deaths-underreported

WHO. (2016b). WHO | Malaria in pregnant women. In *WHO*. World Health Organization. http://www.who.int/malaria/areas/high_risk_groups/pregnancy/en/

WHO. (2017a). *Malaria in pregnant women*. WHO. https://www.who.int/malaria/areas/high_risk_groups/pregnancy/en/

WHO. (2017b). New guidelines on antenatal care for a positive pregnancy experience. *Sexual and Reproductive Health*. http://www.who.int/reproductivehealth/news/antenatal-care/en/

WHO. (2017c). *WHO | Intermittent preventive treatment in pregnancy (IPTp)*. World Health Organization. http://www.who.int/malaria/areas/preventive_therapies/pregnancy/en/

WHO. (2018a). Implementing malaria in pregnancy programs in the context of World Health Organization recommendations on antenatal care for a positive pregnancy experience. In *Brief* (Vol. 64, Issue January). https://doi.org/10.1093/cid/civ881.9

WHO. (2018b). *WHO | Insecticide-treated nets to reduce the risk of malaria in pregnant women*. E-Library of Evidence for Nutrition Actions (ELENA). https://www.who.int/elena/titles/commentary/bednets_malaria_pregnancy/en/

WHO. (2018c). WHO recommendation on daily oral iron and folic acid supplementation | RHL. *The WHO Reproductive Health Library*, *March*, 1–8. https://extranet.who.int/rhl/topics/preconception-pregnancy-childbirth-and-postpartum-care/antenatal-care/who-recommendation-daily-oral-iron-and-folic-acid-supplementation

WHO. (2018d). World Malria Report 2018. In *Licence: CC BY-NC-SA 3.0 IGO*. https://apps.who.int/iris/bitstream/handle/10665/275867/9789241565653-eng.pdf

WHO. (2019a). Guidelines for Malaria Vector Control. In *Guidelines for Malaria Vector Control*. http://www.ncbi.nlm.nih.gov/pubmed/30844152

WHO. (2019b). Guidelines for Malaria Vector Control. In *Guidelines for Malaria Vector Control*.

WHO. (2019c). *Malaria - Key Facts*. Fact Sheets. https://www.who.int/news-room/fact-sheets/detail/malaria

WHO. (2019d). Periconceptional folic acid supplementation to prevent neural tube defects. In *e-Library of Evidence for Nutrition Actions (eLENA)*. World Health Organization. http://www.who.int/elena/titles/folate_periconceptional/en/

WHO. (2019e). *The "World malaria report 2019" at a glance*. December 2019. https://www.who.int/news-room/feature-stories/detail/world-malaria-report-2019

WHO. (2019f). *World Malaria Report*. https://www.mmv.org/sites/default/files/uploads/docs/publications/World Malaria Report_0.pdf

WHO. (2020). *WHO | Core vector control methods*. https://www.who.int/malaria/areas/vector_control/core_methods/en/

WHO Global Malaria Programme. (2020). *New types of insecticide-treated nets*. January 2020. https://www.who.int/news-room/q-a-detail/new-types-of-insecticide-treated-nets

WHO, Hill Jenny, & Kuile, F. ter. (2018). *WHO | Insecticide-treated nets to reduce the risk of malaria in pregnant women - Commentary*. E-Library of Evidence for Nutrition Actions (ELENA). https://www.who.int/elena/titles/commentary/bednets_malaria_pregnancy/en/

WHO Report. (2017). World Malaria Report 2017. In *World Health Organization*.

Wickramasuriya, G. A. W. (1938). Malaria and Ankylostomiasis in the Pregnant Woman: Their More Serious Complications and Sequelæ. *The Indian Medical Gazette*. https://www.semanticscholar.org/paper/Malaria-and-Ankylostomiasis-in-the-Pregnant-Woman%3A-Wickramasuriya/2abd30fc4209f3ebdb2a7a0541c30489f74a5a97

WMHD_GHS. (2017). *Antenatal Care Register: 2015-2018*.

World Health Oranization. (2018). *10+1 Approach- An intensified effort to reduce malaria cases and deaths Getting back on track to achieve the morbidity and* (Issue October). Malaria Policy Advisory Committee Meeting. https://www.who.int/malaria/mpac/mpac-october2018-session5-10plus1-approach.pdf

World Health Organization. (2010). World Malaria Report. In *World Health: Vol. WHO/HTM/GM* (2017th ed., Issue December). WHO. https://doi.org/ISBN 978 92 4 1564403

World Health Organization. (2018). WHO recommendation on antenatal care contact schedules. *The WHO Reproductive Health Library*, *March*, 1–7. https://extranet.who.int/rhl/topics/improving-health-system-performance/who-recommendation-antenatal-care-contact-schedules

Yaya, S., Bishwajit, G., Ekholuenetale, M., Shah, V., Kadio, B., & Udenigwe, O. (2017). Timing and adequate attendance of antenatal care visits among women in Ethiopia. *PLOS ONE*, *12*(9), e0184934. https://doi.org/10.1371/journal.pone.0184934

Yaya, S., Uthman, O. A., Amouzou, A., & Bishwajit, G. (2018). Use of intermittent preventive treatment among pregnant women in sub-Saharan Africa: Evidence from malaria indicator surveys. *Tropical Medicine and Infectious Disease*, *3*(1). https://doi.org/10.3390/tropicalmed3010018

7 PUBLICATIONS & CONFERENCES

7.1 Publications from the doctoral thesis

1. F Dun-Dery, N Kuunibe, P Meissner, V Winkler, A Jahn, O Müller, Determinants of the use of insecticide-treated mosquito nets in pregnant women: a mixed-methods study in Ghana, *International Health*, 2022; ihab087, https://doi.org/10.1093/inthealth/ihab087
2. Dun-Dery, F., Meissner, P., Beiersmann, C., Kuunibe, N., Winkler, V., Albrecht, J., & Müller, O. (2021). Uptake challenges of intermittent preventive malaria therapy among pregnant women and their health care providers in the Upper West Region of Ghana: A mixed-methods study. *Parasite epidemiology and control*, *15*, e00222. https://doi.org/10.1016/j.parepi.2021.e00222 .
3. **F Dun-Dery**, C Beiersmann, N Kuunibe, O Müller **(2020):** Knowledge of malaria risks in pregnancy on use of ITNs among pregnant women in northern Ghana. *European Journal of Public Health* 30(5) DOI. org/10.1093/eurpub/ckaa166.818 (Abstract).

7.2 Other Publications

1. James Atampiiga Avoka, Augustine Ankomah, Agartha Ohemeng, Issah Seidu, Michael Wombeogo, Frederick Dun-Dery (2022): Effects of Pregnancy-Induced Psychological and Emotional Factors on the Occurrence of Preeclampsia/Eclampsia (PE-E) and Haemorrhage. Texila International Journal of Public Health ISSN: 2520-3134 DOI: 10.21522/TIJPH.2013.10.01.Art025
2. Adofo E, Dun-Dery EJ, Kotoh AM, **Dun-Dery F**, *et al*. Fear of infertility limits contraceptive usage among first-time mothers in Ghana: A cross-sectional study. SAGE Open Med. 2021 Jun 3; 9:20503121211021256. doi: 10.1177/20503121211021256. PMID: 34158936; PMCID: PMC8182170.
3. Avoka, J.A., Dun-Dery, E.J., Seidu, I. *et al.* Time series analysis of the relationship between diarrhea in children and Rota 2 vaccine in the Fanteakwa District of the eastern region of Ghana. *BMC Pediatr* **21,** 88 (2021). https://doi.org/10.1186/s12887-021-02540-3
4. EJ Dun-Dery, E Yendaw, **F Dun-Dery**, L Bagrmwin (2019): Correlates of mistimed pregnancy and unmet need for family planning among women of reproductive age in Sandema, Ghana. *Research Square* Doi.org/10.21203/rs.2.19493/v1 (Preprint).
5. **F Dun-Dery**, MN Adokiya, W Walana, E Yirkyio, JB Ziem (2017): Assessing the knowledge of expectant mothers on mother-to-child transmission of viral hepatitis B in the Upper West region of Ghana. *BMC Infectious Diseases* 17(1), 1-10. DOI. 10.1186/s12879-017-2490-x.
6. **Frederick Dun-Dery** (2015): *Childhood Immunization Programs: Why the Dropouts*? LAP Lambert Academic Publishers, Germany. February 2015. ISBN: 978-3659635311

8 ANNEXES

8.1 Data collection tools

8.1.1 Quantitative questionnaire for pregnant women

PREAMBLE

I, Frederick Dun-Dery, a PhD Candidate of Global Health in the University named above, undertaking a study to assess the personal and the health system-related factors affecting the expected uptake of IPTp-SP and ITNs among pregnant women in the Upper West Region. The information you would provide shall solely be used for academic purpose, and your confidentiality shall be maintained. However, your decision to partake in this study should be purely voluntary and at your discretion; in, either way, you would not be penalized. Please thumbprint or sign the consent form if you agree to participate in this study (***Interviewer to ensure this is done if the interviewee is willing***).

INSTRUCTION TO INTERVIEWER

1. *Please carefully choose your response to each question (by circling or writing in the provided space) as required.*

2. *"*"* Means the question requires specific attention while "##" begins another section different from the previous (just ended section).

3. "…(i)" Means *information/attention – please check ANC Booklet for assistance*

4. Inclusion Criteria (Qualification) for sampling:

{If client (**has a gestational age of ≥ 25 weeks i.e. 6+ months**) + (**has Consented**) + (**has finished the day's ANC session**)}

RURAL-URBAN_HEALTH_FACILITY-BASED_QUESTIONNAIRE

No.	Variable	Response Scale
A	**INSTITUTION**: Institute of Global Health, University of Heidelberg, Germany **COUNTRY of field study**: Ghana **REGION**: Upper West Region **DISTRICT**: Wa Municipal [ ] Lambussie [ ]	
B	Consent obtained?	1. Yes [ ] 2. No[ ]***(Skip to next client)*** ⇨
##	**Questions on CLUSTER and FACILITY Characteristics**	
C	Cluster (Sub-district) number and Name	☐☐ Name:…….
D	Facility number and Name	☐☐ Name:……

01	Facility location.	1. Rural [ ] 2. Urban [ ]
02	By what means of transport do you get to this facility for your regular ANC checks?	1. Foot/Walking [ ] 2. Bicycle [ ] 3. Motor cycle [ ] 4. Car/van/taxi, etc. [ ]
03	How long does it take you to arrive at this facility from your home/residence? (*please indicate 0.5hrs or ½hrs for 30minutes, if applicable*)	☐☐ Hour(s)
04	Do you usually spend some money to come to this facility for your normal monthly ANC checks?	1. Yes [ ] 2. No [ ](*If "No" then move to Q6*)
05	How much transport fare do you pay to come to this facility for your ANC services? (*Referring to Q4 above*)	GHS ☐☐
##	**Socio-demographic Characteristics of 3rd Trimester ANC client**	
06	How old are you (years)? (*Interviewer to crosscheck with year of birth on NHIS card and/or ANC record book*)	☐☐
07	Marital Status (*Widowed, cohabiting, separated, are all to be considered as "2"*)	1. Married [ ] 2. Single/Not married [ ] 3. Cohabitating [ ]
08	Has your husband introduced any other woman to you as your co-wife?	1.Yes (Polygamous) [ ] 2. No (Monogamous) [ ]
09*	What work do you do to raise some income to support your family? (All others not indicated here = *"3"*).	1. Farming [ ] 2. Public/Civil service [ ] 3. Private/personal business [ ] 4. Unemployed [ ]
10*	Average monthly income (based on Q09 above). (*Indicate N/A if answer to Q09 = "4"*).	GHS☐☐
11	What form of religious faith do you practice?	1. Christian [ ] 2. Muslim [ ] 3. ATR [ ] 4. Other [ ]
12*	Do you have any formal education?	1. Yes [ ] 2. No [ ](*If No, go to Q14*)

13*	What is your highest level of formal education attained? (*From primary 5 or less = "1"; Primary 6 to JHS 3 = "2"*)	1. No formal education [ ] 2. Junior High [ ] 3. Senior High [ ] 4. Tertiary [ ]
14	What is your household size? (*Number of persons who feed from same cooking*)?	☐☐ people
##	**Questions on Obstetric and Gynaecological Characteristics follow next**	
15	**Gravidity:** is this your 1st, 2nd, 3rd, etc. pregnancy? *Check page 4 of client's ANC booklet*	1. Gravida 1 (if 1st preg.) [ ] 2. Gravida 2 (if 2nd preg.) [ ] 3. Multigravida (if 3rd or >) [ ]
16(i)	Age of pregnancy/Gestation (in complete weeks)? *Refer to page 6 or 7 of ANC Booklet*	☐☐ weeks
17	Gestation at first visit to ANC (*check page 6 or 7 of client's ANC records booklet*)	☐☐ weeks
18*	How many ANC visits have you made so far for this pregnancy? (***Confirm from client's ANC booklet/card***)	☐☐ **Go to Q19** if answer to **Q18 is ≥** 08 (i.e 02 to 08).
19*	Did you make all attendance in **Q118** as your usual ANC visits, or you were also not well?	1. Normal ANC visits [ ] 2. Sick visits included [ ]
20	**Parity:** How many children of your own do you have currently? (*Does not include mortalities*) (check page 4 of ANC card)	Indicate number:…… ……..
21	Any records of low birth weight (<2.5Kg)? (*Please, refer to previous ANC records page 4 of ANC booklet* ***if gravidity is ≥2***)	1. Yes [ ] ……kg 2. No [ ]
22*	Have you missed any of your normal monthly ANC visits since you registered at the facility here? See Page 7 of ANC book	1. Yes [ ] (*number missed*…….) 2. No [ ] Number of ANCs attended…….
23	Have you ever been called/visited by any nurse to find out why you missed (or to remind you of) your ANC schedule?	1. No [ ] 2. Yes [ ]
24	Have you visited any other health facility for your normal monthly ANC checks aside this facility under which you are registered?	1. Yes [ ] 2. No [ ]
##	**IPTp-SP History (Hint:** *crosscheck with client's ANC attendance record***)**	
25*	Have you ever missed or been refused any of your monthly SP doses since you started visiting this health facility for ANC?	1. Yes [ ] 2. No [ ] (***If answer is "No" then skip to continue from Q27***)
26*	What was the cause/reason for this miss/refusal in Q25 above?	1. Missed ANC [ ] 2. Drug shortage at ANC [ ] 3. Other [ ]

27*	How many (monthly) SP-doses have you taken so far since you began attending the ANC? <u>See **page 8** of ANC booklet.</u> *Please request client's contact for FGD sampling if {**(Q27≤3 SP doses)** and **(Q26 is answered as "1" or "3")**}*	☐☐ (indicate 00 if none) (***if missed doses ≤3 and reason in Q25 is "1" or "3" please request contact for FGD sampling***)…… *Check date of last SP dose: ……/……../……
28	Do you usually take your daily drugs such as folic acid on the day of your ANC visit	1. Yes [ ] 2. No [ ]
29	Do the nurses usually ask you about what drugs you have taken before giving you your SP dose?	1. Yes [ ] 2. No [ ]
30*	Are there any signs and symptoms which you associate to SP?	1. Yes [ ] (*please state*…… ……) 2. No [ ] (*if No, continue from Q32*)
31	Does any of these signs and symptoms in 29 discourage you from taking your SP?	1. Yes [ ] 2. No [ ]
32*	HIV Antibody (PMTCT) status? **(Please do not ask client directly**. ***Page 6*** *of client's ANC book*)	1. 279 [ ] 2. 280 [ ] 3. No record [ ]
33	HBsAg status **(Please do not ask client directly**. *Instead, check page 6 of the client's ANC booklet*)	1. Reactive +ve [ ] 2. Non-reactive -ve [ ] 3. No record [ ]
34*	G6PD status (*Please check page 6 of client's ANC booklet. Don't ask client!*)	1. Partial defect [ ] 2. Full defect [ ] 3. No defect [ ]
35*	VDRL/Syphilis status *See **page 6** of client's ANC booklet*	1. +ve [ ] 2. -ve [ ]
36*	PF for Malaria *See **page 6** of client's ANC booklet*	1. +ve [ ] 2. -ve [ ]
##	**Questions on ITNs ownership and usage will follow next**	
37*	Long Lasting Insecticide Treated Net (LLIN) supplied? (*Check **page 8** ANC book*)	**1. Yes [ ] *Date:……..*** **2. No [ ]**
38	Do you sleep under a mosquito net regularly?	1. Yes [ ] 2. I don't [ ] because…….. ……
39*	Does your household own any mosquito nets?	1. Yes [ ] 2. No [ ] (*if No, continue from Q41*)
40*	Who sleeps under these nets?	1. Children [ ] 2. Only the men [ ] 3. I do [ ](*if 3 is chosen, then go to Q42*) 4. Others [ ](state……..)
41*	Why do you not sleep under an ITN	…… ……..

		……..
42	Are these bed nets treated with insecticide	1. Yes [ ] 2. No [ ]
43*	When was the last time you slept under a mosquito net? (***If answer is ≥ 2days, request phone number for FGD sampling***)	☐☐ day(s) ago Phone num: ……
44	For how long have you been using your current mosquito net? (*Calculate in complete months*)	☐☐ month(s)
45	Do your children and husband also sleep under mosquito nets?	1. Yes [ ] 2. No [ ](reason:…… .....
##	**Mother's Knowledge on Risks of Malaria in pregnancy**	
46	In your opinion, what is the main cause of malaria?	1. Mosquito bites [ ] 2. Eating other dirty food or drinking dirty water [ ] 3. Cold or changing weather [ ] 4. Do not know [ ]
47*	What are the main methods used to protect yourself against getting malaria in your family? (*Please do not pre-empt answers to client but rather compare what she says to answer keys: 1 to 7*) ⇨	1. Sleep under a bednet [ ] 2. Sleep under an insecticide-treated bednet [ ] 3. Use mosquito repellent [ ] 4. Take preventive medication[] 5. Spray house with insecicide[] 6. Other []…… 7. Do not know [ ]
48*	Have you ever been sick of malaria since you got pregnant? (*Referring to current pregnancy*)	1. Yes [ ] (continue from Q49) ⇨ 2. Been sick but don't know if it was malaria or not [ ] 3. Not been sick [ ]
49	Was your sickness tested and confirmed as malaria in a health facility or lab?	1. Yes [ ] 2. No [ ]
50*	Do you think if you get malaria, it can cause any serious harm to you and your unborn child?	1. Yes [ ] 2. No [ ] (***skip Q51 if answer is "No"***)
51*	In what ways do you think your malaria can harm your unborn baby?	1. …… ⇨ 2…….. 3…….. 4……..
52	Do you agree the 1st SP dose is the most important and can protect you and the unborn child from malaria till delivery? *(2=3)*	1. False [ ] 2. True [ ] 3. I don't know [ ]
53	You don't need to take SP if you are not sick (of malaria)	1. False [ ] 2. True [ ]

54	Do you think the SP drugs rather cause you harm and your unborn babies?	1. No [ ] 2. Yes [ ]
55*	Have you ever lost a pregnancy (miscarriage) or suffered a stillbirth? (*Check obstetric records of previous pregnancies if available*)	1. No [ ](***go to Q57 if answer is "No"***) 2. Yes [ ]
56*	Were you ever sick (of malaria) during that pregnancy in Q52 above?	1. Yes [ ] 2. No [ ] 3. I can't remember [ ]
57	On your usual ANC days, do you take your folic acid tablet before coming to the facility?	1. Yes [ ] 2. No [ ] (Reason…….. …….)
58	Does the attending ANC nurse usually ask you about your folic acid history before giving you the SP?	1. Yes [ ] 2. No [ ]
NB	***End of interview FOR ANC CLIENT***	

8.1.2 Quantitative questionnaire for ANC providers

PREAMBLE

I, Frederick Dun-Dery, a PhD Candidate of Global Health in the University named above, undertaking a study to assess the personal and the health system-related factors affecting the expected uptake of IPTp-SP and ITNs among pregnant women in the Upper West Region. The information you would provide shall solely be used for academic purpose, and your confidentiality shall be maintained. However, your decision to partake in this study should be purely voluntary and at your discretion; in, either way, you would not be penalized. Please thumbprint or sign the consent form if you agree to participate in this study (***Interviewer to ensure this is done if the interviewee is willing***).

##	**FOR ANC STAFF ONLY!!!** **Please obtain consent from selected staff member to proceed** **(Staff knowledge on IPTp-SP and ≥1mg folic acid combination)**	
No.	Variable	Response Scale
A	**INSTITUTION**: Institute of Global Health, University of Heidelberg, Germany **COUNTRY of field study**: Ghana **REGION**: Upper West Region **DISTRICT**: Wa Municipal [ ] Lambussie [ ]	
B	Consent obtained from staff?	1. Yes [ ] 2. No [ ] (*If "No" then skip to next staff*)
##	**Questions on CLUSTER and FACILITY Characteristics**	
C	Cluster (Sub-district) number and Name	☐☐ Name:……..
D	Health Facility number and Name:	☐☐ Name:……..
E	Gender	Male [ ] Female [ ] Other [ ]
01	How many kilometres is your facility from the nearest referral health facility? (*98=do not know*).	☐☐
02*	Professional qualification (by training) (*If the answer is "1" then **skip** Q03)*	1. Midwife [ ] 2. Community Health Nurse [ ] 3. Other [ ] (state…….)
03*	Have you had any form of midwifery training?	1. Yes [ ] 2. No [ ]
04	For how long have you been officially attending to ANC clients on their regular ANC checks?	1. Less than 1year [ ] 2. 1-2 years [ ]

		3. 3-4 years [ ] 4. 5 or more years [ ]
05	What does the abbreviation "IPTp-SP" mean? (*Interviewer to write exact answer as given by ANC staff*)	……. …….
06	How many main types of drugs/supplements are recommended for pregnant women until delivery?	1. Four [ ] 2. Three [ ] 3. Two [ ] 4. One [ ]
07	List the recommended drugs/supplements given to pregnant women on their regular ANC visits. (*Interviewer should refer to answer sheet to compare staff response*)	1. None [ ] 2. 1 correct [ ] 3. 2 correct [ ] 4. 3 correct [ ] 5. All correct [ ]
08	Every pregnant woman should immediately start SP therapy the moment she is confirmed pregnant. (*1=3*)	1. True [ ] 2. False [ ] 3. I don't know [ ]
09	When is the earliest point in time that SP can be safely administered in pregnancy?	…….. ……..
10	What is the relationship between "*quickening"* and SP?	…… ……
11	What is the GHS *recommended daily dose* of folic acid?	……...
12*	Is there any drug(s) in the answers to **"Q07"** above that can interfere with the desired function of SP when combined? (*Indicate name if answer is "1"*)	1. Yes [ ]: …… 2. No [ ] 3. I don't know [ ]
13	The SP is safe and functions well with cotrimoxazole for HIV-infected pregnant women. (2=3)	1. False [ ] 2. True [ ] 3. I have no idea [ ]
14	On what recommended standard condition should folic acid not be combined with SP?	……
15	What is the current *minimum* number of GHS recommended SP doses a pregnant woman should take by the time of delivery?	☐☐
16	What do you do when a pregnant woman resists that SP tastes 'bitter' or weird when taken with 'plain' water?	…….. ……..
17	Is there a recommended protocol to manage possible side effects such as nausea, weakness, dizziness, and vomits, following the intake of (especially first dose of) SP?	1. No protocol [ ] 2. I don't know [ ] 3. Yes [ ](summarize protocol):…….
18*	Do you sometimes have stockouts/shortages of SP drugs?	1. Yes [ ] 2. No [ ] *If **No** then go to Q24*
19	How often do you experience SP stockout?	1. Daily/every other day [ ] 2. Almost every week [ ]

		3. Other [ ] (*state……..*)
20*	Has this shortage in Q18 above affected SP provision to pregnant women?	1. Yes [ ]*(if Yes continue from **Q21**,)* 2. No [ ] (*If No, then **Q24**)*
21	In what way does SP shortage affect pregnant women?	……. …….
22	What do you do when you run out of SP supplies during an ANC session?	……... ……...
23	How long does it take to restock your facility with SP when you run out of stock?	1. 1 day [ ] 2. Less than a week [ ] 3. More than a week [ ]
24	Do you keep specific records of which pregnant woman comes for which specific ANC schedule?	1. Yes [ ] 2. No [ ]
25	After each ANC day/session, are you able to tell how many pregnant women missed the session and who they are?	1. Yes [ ] 2. No [ ]
26	What do you normally do when you realize an ANC client you expect at a session does not turn up?	…… ……
27	The old ANC record cards have provisions for only SP1-SP3. Where and how did you report SP4 and SP5?	…….. ……..
28	From your experience, how do you think we can encourage more pregnant women to complete their SP1 to SP5 to increase coverage?.....	…….. ……..
NB	**End of interview for ANC STAFF**	

8.1.3 Qualitative Data Collection Tool – Focus Group Discussion Guide

Focus Group Discussion Guide

Consent Process

Consent forms for focus group participants are completed in advance by all those seeking to participate. Below is a summary of the information in the consent form that focus group organizers and facilitators should use to make sure participants understand the information in the consent form.

Thank you for agreeing to participate. We are very interested to hear your valuable opinion on how the Ministry of Health and the Ghana Health Service can adjust the IPTp-SP and ITNS policies to your optimum health during and after pregnancy.

- The purpose of this discussion is to gather and understand your opinions regarding why you seem to have difficulties in using ITNs as well as taking SP.
- The information you give us is completely confidential, and we will not associate your name with anything you say in this discussion.
- We would like to tape/record the discussion so that we capture the thoughts, opinions, and ideas exactly as discussed. No names will be attached during transcription and reporting, and the tapes will be destroyed as soon as they are transcribed.
- You may refuse to answer any question or withdraw from the study at any time.
- We understand how important it is that this information is kept private and confidential. We will ask you (participants) to respect each other's confidentiality.
- If you have any questions now, during, or after you have completed the discussion, you can always contact a study team member like me, or you can call the project team leaders whose names and phone numbers are on the information sheet.
- Please check the boxes on the last page and sign/thumbprint to show you agree to participate in this focus group discussion.

Introduction

1. **Welcome**

   Introduce yourself and the notetaker with a few quick demographic questions (age, cadre e.g., student researcher, role in the study and in the FGD, relation with the GHS facilities, etc.) and

send the Sign-In Sheet (containing participant name, sub-district, residing community, gestational age) around to the group while you are introducing the focus group.

Review the following:

- Who we are and what we are trying to do.
- What will be done with this information.
- Why we need you to participate.

2. Explanation of the process:

- Ask the group if anyone has participated in a focus group before. Explain that focus groups are being used more and more often in health and human services research.
- Explain that the discussion will be in two sessions:
    - Session 1 will involve discussion on IPTp-SP to share their concerns about affects their regular uptake of SP and what they would prefer.
    - Session 2 will consider the issues of ITNs also to know their difficulties and what they would prefer that could help them use ITNs regularly.
    - *Each session would last for a maximum of about 45 minutes.*

About this focus group

- We would like to learn from your experiences (positive and negative)
- We are not trying to achieve consensus; we are gathering information.
- No virtue in long lists: we are looking for priorities. Please try to avoid other people's private matters. Just share your honest opinion and/or experience that you believe will make an excellent change to our health system.
- In this project, we are doing both questionnaires and focus group discussions. The reason for using both tools is that we can get more in-depth information from a smaller group of people in focus groups. This allows us to understand the context behind the answers given in the written survey and explore the topic in more detail than we can do in the written survey we did with you in the facilities before today.
- The entire focus group will last about forty-five minutes.
- Feel free to move around.
- Where is the bathroom? Exit?

- Help yourself to refreshments anytime.

3. **Ground Rules**

   Ask the group to suggest some ground rules. After they brainstorm some, make sure the following are on the list.

   - Everyone should feel free to participate.
   - Information provided in the focus group must be kept confidential.
   - Stay with the group, and please do not have side conversations.
   - **Turn off cell phones if possible.**
   - Feel free.

4. **Turn on Tape Recorder.**
5. Ask the group if there are any questions before we get started and address those questions.
6. **Introduction**
   - Go around the table (or horse-shoe seating formation):
     - which community do you stay?
     - how accessible is transportation to your community from here (referring to the venue of FGD)?

(Discussion begins, make sure to give people time to think before answering the questions and not moving too quickly. Use the probes to ensure that all issues are addressed but move on when you feel you are starting to hear repetitive information).

Common opening:

1. Let us start the discussion by talking about what you know about malaria. Why should especially pregnant women worry about malaria?
2. How are you (pregnant women) protecting yourself from mosquito bites?

Session 1: IPTp-SP

3. In your understanding, what is this SP to you?
4. How important is it for you (in pregnancy)?
5. What factors contribute to your decision to skipping your SP doses?
6. Anything else that poses a challenge to anyone of you? Please feel free to say it as your challenge.

7. What do you suggest, if done, would help you keep to your SP schedule?

Session 2: ITNs

8. What factors contribute to your decision not to sleep under an ITN?
9. What do you suggest, if done, would help you use an ITN always and effectively?

Probes for Discussion:

- *Is it more ITNs you need?*
- *How do you think the nurses can help you improve early ANC booking?*
    - *Would the supply of free pregnancy test kits and education on how to use them, so you know early when you are pregnant?*
- *Is it your family head/husband inclusiveness?*
- *Would you prefer any form of reminders to use your ITN and/or go for your SP therapy?*
    - *Through Community Health Volunteers ?*
    - *Mobile phone calls/text messages ?*
- *Are there any other benefits you would need as motivation to help you keep using your ITN (or take your SP drugs)?*

Conclusion

That concludes our focus group. Thank you so much for coming and sharing your thoughts and opinions with us. We have a short evaluation form that we would like you to fill out if you have time. If you have additional information that you did not get to say in the focus group, please feel free to write it on this evaluation form.

Materials and supplies for focus groups

- Sign-in Form (*attached overleaf)*
- Focus Group Discussion Guide for the facilitator.
- 1 audio recording devices
- Batteries for recording devices
- Extra memory card for recording devices
- Permanent marker for marking tapes with FGD name, facility, and date.
- Notebook for taking notes.

- Pens and Pencils for taking notes.
- Refreshments / travel and transport fares for participants.

8.1.4 Focus Group Participants' Attendance Sheet

To be completed by FGD records officer and/or FGD Administrator in consultation with FGD participants

FGDs: Participant Sign-In Sheet							
S/N	Respondent's Name	Age (yrs)	Gestational age (wks)	Sub-District	Community	IPTp or ITN?	Sign/Thumb print
01							
02							
03							
04							
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							

Date: …….. Time FGD started: ……Time FGD ended……..

Questions for FGD Administrator

1. What other observations did you make/notice during the FGD, which otherwise cannot be determined from the audio?

……

……

2. How did you react/respond to such observations at the time (or after)?.....

Name of FGD Administrator: ……Signature……..

Witness (to FGD)

Name: …… Signature: ……..

Telephone: …….

Venue (where FGD took place): …….

NB: ***For immediate clarification(s), please call either +233(0)248710709 or +233(0)208321874.***

NB: *Before leaving the venue, please ensure that all participants are in normal condition as they came and may have left.*

8.2 Participants' Information sheets

8.2.1 Information sheet for pregnant women

Study title: Malaria Control among Pregnant Women in Ghana: A mixed-methods study on the Uptake of Intermittent Preventive Treatment and Insecticide Treated Mosquito Nets

Information for ANC providers

Introduction/Purpose of study:

Dear participant, *with this letter we invite you to participate in the above study. Please read the following information carefully. You can then decide if you want to participate or not. Give yourself enough time and ask the study staff all the questions that are important to you. The study is funded by the German Catholic Academic Exchange Service (KAAD), based in Bonn, Germany.*

What is the goal of the study?

We are conducting a study to assess the personal and the health system-related factors affecting the expected uptake of IPTp-SP and ITNs among pregnant women in the Upper West Region. This is meant to find out some of the fundamental challenges or difficulties pregnant women in the Upper West Region may be encountering in adhering to your IPTp-SP as well as the usage of ITN at home. The overall goal is to strengthen existing efforts in designing target-specific approaches to help pregnant mothers (and families by extension) towards healthier pregnancy experiences to reduce materno-foetal dangers while creating healthier, happier homes.

How does the study work?[1] (Study Procedure)

You, as the study participant, will be politely approached by one of our designated field staffs (Research Assistant) when you are done with your routine antennal care (ANC) assessment. He/she will then check your ANC records to see if you qualify to participate. Further, the field staff will give you enough explanation in your preferred language on what is required of you and your rights as well participate in this study. You are entitled to ask for clarification where you find it necessary. If you agree to have understood the information read and explained to you, the field staff will assist you to either sign or thumbprint a Consent Form to show your agreement to participate in this study. After which he or she will go ahead to ask you some questions as well as check some of your antenatal records as and when necessary, and this would last about 40minutes. Your personal information will not be requested unless you qualify for our next stage of this study. In that case, you will be assigned a unique identifier code which will be discussed with you and your ANC staff. This shall be used by only your ANC staff to reach you, when necessary, after which it shall be destroyed to avoid any further leads to your privacy. You are free to ask for clarification or not to answer as and when you find it necessary. At the successful end of the question-and-answer session, we may invite you later through your ANC staff and/or Community Health Volunteer to further participate in another aspect of this study.

What are the risks associated with participation?

As a pregnant woman participating in this study, it is possible that you could go into labour any moment during the administration of questionnaires. To ensure that any such possibility is minimized, avoided, or adequately controlled, the data will be collected at the health facilities, and the attending health service providers will usually be pre-informed to be on the lookout.

Aside from that, the study procedures are entirely non-invasive: they do not involve drawing of bodily fluids or bodily parts for diagnostics, neither does it involve the consumption of any substance from the field staffs. As such, it has no direct risks on you: you will not lose any personal belongings or privacy; there are no conflicts of interest; you are also of your confidentiality by ensuring complete anonymity of your data.

Information on data protection

General:

The medical confidentiality and data protection regulations are observed. During the study, medical findings and/or personal information such as your routine diagnostics test results of hepatitis B, HIV, malaria, Syphilis, and G6PD; history of low birth weight, lost pregnancy, your age, marital status, parity and gravidity, and the gestational age of your current pregnancy will be collected from you and written down in our personal file and/or stored electronically in the testing centre. The data important for the study are additionally [2] stored in pseudonymous form, evaluated and, if necessary, at Heidelberg University/clinic, etc. may also be available to countries where data protection requirements are lower than in the European Union.[3] The study management will take all reasonable steps to ensure the protection of your data in accordance with the data protection standards of the European Union. The data is secured against unauthorized access. Decryption is only done in case of withdrawal from the study for the purpose of data destruction. As soon as it is possible after the research or statistical purpose, the personal data is anonymized.[4] The data collected during the study may be destroyed 10 years after the successful academic publication of as well as a successful submission of the monograph from this data.

The data will be used exclusively for the purposes of this study *as* well as to support research in the field of the prevalence of G6PD and/or anemia in pregnancy in the future. *The study participant should be advised that, for other/future research purposes, he may limit the use of data in the declaration of consent.*

[2] *The following definition should be included in the Inserted to become:* 'pseudonymisation' means the processing of personal data in such a way that personal data can no longer be assigned to a specific data subject without the use of additional information ('keys'). This additional information is kept separately and is subject to technical and organisational measures to ensure that the personal data is not assigned to an identified or identifiable natural person.

[3] *Note to the author: If the data is passed on to countries with less data protection requirements than in the European Union, the data subject must be expressly advised to do so.*

[4] *The following definition should be included in the Inserted to become: "*Anonymisation" means the modification of personal data in such a way that the data subject can no longer be identified or only with a disproportionate cost or time.

You have the right to request information from the controller (see above) about the personal data you have stored. You can also request the correction of inaccurate data as well as the deletion of the data or restriction of their processing. The person responsible for the study-related collection of personal data is: Frederick Dun-Dery +233 208321874 Student Investigator

Voluntary Participation/Withdrawal or Resignation

Participation in the study is voluntary. If you would like to participate, please sign the enclosed declaration of consent. You can revoke this consent at any time in writing or orally without giving any reason, without incurring any disadvantages. If you wish to revoke your consent, please contact the study administration or the staff treating you. In the case of a revocation, you can decide whether the study data collected by you should be destroyed/samples taken/created recordings or continue to be used for the purposes of the study. Even if you initially consent to further use, you can subsequently change your mind and request the deletion of the data/destruction of the samples/recordings; Please also contact the study administration or the staff treating you.

Please note that data that has already flowed into scientific evaluations or data/samples/ recordings that have already been anonymised can no longer be deleted/destroyed at your request.

If you have any concerns about data processing and compliance with data protection requirements, you can contact the following data protection officer of the institution:
The State Commissioner for Data Protection and Freedom of Information Baden-Württemberg

PO Box 10 29 32, 70025 Stuttgart
Königstrasse 10a, 70173 Stuttgart
Tel: +49(0)711/61 55 41 - 0
Fax: +49(0)711/61 55 41 - 15
E-Mail: poststelle@lfdi.bwl.de
Internet: http://www.baden-wuerttemberg.datenschutz.de

For the purposes of the study, it is useful/necessary to include data from your medical file with your treating doctor/ your GP. We would like to ask you to agree to partial disclosure of the data specified below [to name the data to be *collected in the further course]* to the study management and to agree to your treatment / to release your family doctor from the obligation of confidentiality in this respect.

Does the participation cost me? / Will I receive a payment or allowance?

Study participation is free for you; likewise, you will also receive no payment. However, participants of the FGDs will usually be provided refreshment after the session and given a maximum of twenty Ghana cedis (GHC 20.0) each as transportation fare to assist them to travel back to their homes in good time and convenience. You will also be informed of the possible future benefits you will get when the feedback you shall provide will be used by the relevant stakeholders

to progressively improve your health conditions resulting in improved maternal and child health outcomes.

For more information

For further information as well as information on general results and the outcome of the study, as head of the study For further information, as well as information on general results and the outcome of the study, please contact Prof. Dr. med Olaf Müller (Phone: +49 6221 56 4904, Email: olaf.mueller@uni-heidelberg.de) as head of the study. **Or**

The Administrator
Disease Control in Disadvantaged Populations
Heidelberg Institute of Global Health
Im Neuenheimer Feld 130.3
DE-69120 Heidelberg, Germany.
Email: hilde.gold@uni-heidelberg.de,
Tel: +49 6221 56 4904

Contact in Ghana:

Alternatively, participants can also contact the research team in Ghana through the following contact details when the need arises:

1. +233 208321874 Student Investigator – (direct)
2. +49 1521 3599531 Student Investigator – (direct)
Email: frederick.dundery@uni-heidelberg.de **(Student Investigator)**

We would be grateful for your participation in this research project!

8.2.1 Information sheet for ANC providers

Study title: Malaria Control among Pregnant Women in Ghana: A mixed-methods study on the Uptake of Intermittent Preventive Treatment and Insecticide Treated Mosquito Nets

Introduction/Purpose of study

Dear participant, *with this letter we invite you to participate in the above study. Please read the following information carefully. You can then decide if you want to participate or not. Give yourself enough time and ask the study field staff all the questions that are important to you. The study is funded by the German Catholic Academic Foreign Service (KAAD), based in Bonn, Germany.*

What is the goal of the study?

We are conducting a study on the personal and health system-related factors affecting the expected uptake of IPTp-SP and ITNs among pregnant women in the Upper West Region. This is meant to find out some of the fundamental challenges or difficulties pregnant women in the Upper West Region may be encountering in adhering to your IPTp-SP as well as the usage of ITN at home. The overall goal is to strengthen existing efforts in designing target-specific approaches to help pregnant mothers (and families by extension) towards healthier pregnancy experiences to reduce maternofoetal dangers while creating healthier, happier homes.

How does the study work?[5] (Study Procedure)

You, as the study participant, will be politely approached by one of our designated field staffs (Research Assistant) when you are done with your routine antennal care (ANC) assessment or at an arranged time. He/she will then give you enough explanation in your preferred language on what is required of you and your rights as well to participate in this study. You are entitled to ask for clarification where you find it necessary. If you agree to have understood the information read and explained to you, the field staff will assist you to either sign or thumbprint a Consent Form to show your agreement to participate in this study. After which, he or she will go ahead to ask you some questions, as well as check some of your antenatal records as and when necessary and this, would last about 40 minutes. Your personally identifiable information will not be requested unless otherwise stated. In that case, you will be assigned a unique identifier code which will be discussed with you. This shall be used by only our study team to reach you when necessary, after which it shall be destroyed to avoid any further leads to your privacy. You are free to ask for clarification or not to answer as and when you find it necessary.

What are the risks associated with participation?

The study procedures are entirely non-invasive: they do not involve drawing of bodily fluids or bodily parts for diagnostics, neither does it involve the consumption of any substance from the field staffs. As such, it has no direct risks on you: you will not lose any personal belongings or

privacy; there are no conflicts of interest; you are also assured of your confidentiality by ensuring complete anonymity of your data.

Information on data protection

General:

The medical confidentiality and data protection regulations are observed. During the study, personal information such as your professional background; years of work experience; gender, your age, marital status, and your knowledge on the administration requirements of the SP drug to Pregnant women according to WHO policy will be collected from you and written down in our personal file and/or stored electronically in the testing centre. The data important for the study are additionally [6] stored in pseudonymous form, evaluated and, if necessary, at Heidelberg University/clinic, etc. may also be available to countries where data protection requirements are lower than in the European Union.[7] The study management will take all reasonable steps to ensure the protection of your data in accordance with the data protection standards of the European Union. The data is secured against unauthorized access. Decryption is only done in case of withdrawal from the study for the purpose of data destruction. As soon as it is possible after the research or statistical purpose, the personal data is anonymized.[8] The data collected during the study may be destroyed 10 years after the successful academic publication of as well as a successful submission of the monograph from this data.

The data will be used exclusively for the purposes of this study. *[The study participant should be advised that, for other/future research purposes, he may limit the use of data in the declaration of consent].*

You have the right to request information from the controller (see above) about the personal data you have stored. You can also request the correction of inaccurate data as well as the deletion of the data or restriction of their processing. The person immediately responsible for the study-related collection of personal data is Frederick Dun-Dery +233 208321874, the Student Investigator.

Voluntary Participation/Withdrawal or Resignation

Participation in the study is voluntary. If you would like to participate, please sign the enclosed declaration of consent. You can revoke this consent at any time in writing or orally without giving any reason, without incurring any disadvantages. If you wish to revoke your consent, please contact the study administration or the staff treating you. In the case of a revocation, you can decide

[6] *The following definition should be included in the Inserted to become:* 'pseudonymisation' means the processing of personal data in such a way that personal data can no longer be assigned to a specific data subject without the use of additional information ('keys'). This additional information is kept separately and is subject to technical and organisational measures to ensure that the personal data is not assigned to an identified or identifiable natural person.
[7] *Note to the author: If the data is passed on to countries with less data protection requirements than in the European Union, the data subject must be expressly advised to do so.*
[8] *The following definition should be included in the Inserted to become: "*Anonymisation" means the modification of personal data in such a way that the data subject can no longer be identified or only with a disproportionate cost or time.

whether the study data collected by you should be destroyed/samples taken/created recordings or continue to be used for the purposes of the study. Even if you initially consent to further use, you can subsequently change your mind and request the deletion of the data/destruction of the samples/recordings; Please also contact the study administration or the field staff attending to you.

Please note that data that has already flowed into scientific evaluations or data/samples/ recordings that have already been anonymised can no longer be deleted/destroyed at your request.

If you have any concerns about data processing and compliance with data protection requirements, you can contact the following data protection officer of the institution:
The State Commissioner for Data Protection and Freedom of Information Baden-Württemberg

PO Box 10 29 32, 70025 Stuttgart
Königstrasse 10a, 70173 Stuttgart
Tel: +49(0)711/61 55 41 - 0
Fax: +49(0)711/61 55 41 - 15
E-Mail: poststelle@lfdi.bwl.de
Internet: http://www.baden-wuerttemberg.datenschutz.de

Does the participation cost me? / Will I receive a payment or allowance?

Study participation is free for you; likewise, you will also receive no payment. You will also be informed of the possible future benefits you will get when the feedback you shall provide will be used by the relevant stakeholders to progressively improve your health conditions resulting in improved maternal and child health outcomes.

For more information

For further information as well as information on general results and the outcome of the study, as head of the study For further information, as well as information on general results and the outcome of the study, please contact Prof. Dr. med Olaf Müller (Phone: +49 6221 56 4904, Email: olaf.mueller@uni-heidelberg.de) as head of the study. **Or**

The Administrator
Disease Control in Disadvantaged Populations
Heidelberg Institute of Global Health
Im Neuenheimer Feld 130.3
DE-69120 Heidelberg, Germany.
Email: hilde.gold@uni-heidelberg.de,
Tel: +49 6221 56 4904

Contact in Ghana:

Alternatively, participants can also contact the research team in Ghana through the following contact details when the need arises:

1. +233 208321874 Student Investigator – (direct)
2. +49 1521 3599531 Student Investigator – (direct)

Email: frederick.dundery@uni-heidelberg.de **(Student Investigator)**

We would be grateful for your participation in this research project!

8.3 Participants' Consent Forms

8.3.1 Consent for pregnant women

Consent Form

I have read the information and have also been informed orally by Mr./Mrs _____ [*name of attending field staff*] about the purpose and course of the study, as well as about the risks in detail and in a comprehensible manner. In the context of the enlightenment discussion, I had the opportunity to ask questions. All my questions were answered to my satisfaction. I voluntarily agree to participate in the study. I had plenty of time to make my decision. I have received a copy of the information document and the declaration of consent.

I agree with the notification of random findings:

Yes □

Yes, if the possibility of preventing or treating diseases is likely to be possible. □

No □

Privacy

I am aware that this study is intended to **process personal data. The** processing **of the** data is carried out in accordance with legal provisions and **requires** the **following** declaration **of consent** in accordance with Article **6 (1)** of the General Data **Protection Regulation:**

I have been informed and voluntarily agree **that my data collected in the study, in particular my health[9] information,** will be used in pseudonymised terms for **the purposes described in the information document. Form recorded, evaluated and, if necessary, also in pseudonymised form** at Heidelberg university/clinic**, may also** be able to be passed on to countries with lower data protection requirements than in **the European Union. Third parties do not gain access to personal documents. My name is also not mentioned when publishing the results of the study. The personal data will be anonymised as soon as this is possible according to the research purpose. The data will be destroyed or retained 10 years after successful academic publication and/or graduation following the completion of the data evaluation. I am aware that this consent can be revoked at any time in writing or orally without giving reasons, without causing me any disadvantages. This shall not affect the legality of the data processing carried out until the revocation. In this case, I can decide whether the data I have collected should be deleted or may continue to be used for the purposes of the study.**

Please insert if the data is also to be used for other/future research purposes:

[9] Pursuant to Article 9(1) GDPR, health data are personal data of a particular category in the processing of which the study participants must expressly consent to. The same applies to data, which show racial and ethnic origin, political opinions, religious or ideological beliefs or trade union membership, as well as for the processing of genetic data, biometric data for unambiguous identification of a natural person, data on sex life or sexual orientation.

I would like to limit the use of my data for other/future research purposes as follows:

...to support future research in assessing the prevalence of G6PD and/or anemia in pregnancy.

I agree with the notification of my participation in the research project through the application to the competent authority. The statements made by **the** performing field staff in **this context and** records shall **be kept for 30 years after their submission or the date of application and shall be submitted to the competent authority at the request of the competent authority.**

_____
Location, Date

_____
Name, First name of Participant (in Printed letters)

_____
Signature or thumbprint of the Participant

Enlightening person

The patient/subject was informed by me during a conversation about the purpose and the course of the study as well as about the risks. I have handed over a copy of the information document and the declaration of consent to the patient/subject.

_____
Location, Date

_____
Name, First name of the enlightening person
(in Printed letters)

_____
Signature of the Enlightening Person

8.3.2 Consent for ANC providers

Consent Form

I have read the information and have also been informed orally by Mr./Mrs _____ [*name of attending field staff*] about the purpose and course of the study, as well as about the risks in detail and in a comprehensible manner. In the context of the enlightenment discussion, I had the opportunity to ask questions. All my questions were answered to my satisfaction. I voluntarily agree to participate in the study. I had plenty of time to make my decision. I have received a copy of the information document and the declaration of consent.

I agree with the notification of random findings:

Yes □

Yes, if the possibility of preventing or treating diseases is likely to be possible. □

No □

Privacy

I am aware that this study is intended to **process personal data. The** processing **of the** data is carried out in accordance with legal provisions and **requires** the **following** declaration **of consent** in accordance with Article **6 (1)** of the General Data **Protection Regulation:**

I have been informed and voluntarily agree **that my data collected in the study, my health[10] information, will** be used in pseudonymised terms for **the purposes described in the information document. Form recorded, evaluated and, if necessary, also in pseudonymised form** at Heidelberg university/clinic**, may also** be able to be passed on to countries with lower data protection requirements than in **the European Union. Third parties do not gain access to personal documents. My name is also not mentioned when publishing the results of the study. The personal data will be anonymised as soon as this is possible according to the research purpose. The data will be destroyed or retained 10 years after successful academic publication and/or graduation following the completion of the data evaluation. I am aware that this consent can be revoked at any time in writing or orally without giving reasons, without causing me any disadvantages. This shall not affect the legality of the data processing carried out until the revocation. In this case, I can decide whether the data I have collected should be deleted or may continue to be used for the purposes of the study.**

I agree with the notification of my participation in the research project through the application to the competent authority.

_____ _____

Location, Date

[10] Pursuant to Article 9(1) GDPR, health data are personal data of a particular category in the processing of which the study participants must expressly consent to. The same applies to data, which show racial and ethnic origin, political opinions, religious or ideological beliefs or trade union membership, as well as for the processing of genetic data, biometric data for unambiguous identification of a natural person, data on sex life or sexual orientation.

Name, First name of Participant (in Printed letters)

_____
Signature or thumbprint of the Participant

Enlightening person

The patient/subject was informed by me during a conversation about the purpose and the course of the study as well as about the risks. I have handed over a copy of the information document and the declaration of consent to the patient/subject.

Location, Date_____

Name, First name of the enlightening person (in Printed letters) _____

Signature of the Enlightening Person……..

FREDERICK DUN-DERY

Im Neuenheimer Feld 136a 69120 Heidelberg, Germany	frederick.dundery@uni-heidelberg.de; kuanufred@gmail.com	+49(0) 17673862983

Summary

- A public health specialist with over 5 years of accumulated research experience in maternal and child health, infectious disease epidemiology, disease surveillance, health intervention studies, tropical communicable disease, and global health.
- Has over 3 years' experience in applying advanced statistical methods in analyzing large epidemiological data: sensitivity analyses, prevalence estimation.
- Proficient in disseminating research findings in seminars and conferences, as well as supervising and giving tutorials to students.

University Education

05.2018 – 04.2022 **Heidelberg University, Heidelberg, Germany**
PhD Global Health
Thesis title: Uptake challenges with the WHO recommended IPTp-SP and ITNs policies against malaria infection in pregnancy.
Supervisor: Prof. Dr. med. Olaf Mueller

2013 – 2016 **University for Development Studies, Tamale, Ghana**
Master of Philosophy, Community Health and Development
Dissertation title: Preventing Mother-to-Child Transmission of viral hepatitis B.
Supervisor: Prof. Dr. Juventus B. Ziem

2008 – 2012 **University of Ghana/Catholic University (CUG), Fiapre, Ghana**
BSc (Hons.) Public Health
Project work: Factors associated with immunization dropout rates among under-fives.
Supervisor: Dr. Henry Ofosu Addo

Research and Professional Experience

08.2021-04.2022 **Research Scientist**
Heidelberg Institute of Global Health, Heidelberg, Germany

- Conducts systematic literature search for manuscripts
- Writes a summary chapter for project-related papers.
- Provides weekly group updates on progress of work.
- Analyses of large clinical and epidemiological data: prevalence estimation, sensitivity analyses, response rates, participants' Likert scale feedback.
- Manages and analyses qualitative data on participants' satisfaction survey
- Co-authors research findings for publication in peer-reviewed journals.

10.2017–09.2021 **Doctoral Research Fellow**
Heidelberg Institute of Global Health, Heidelberg, Germany

- Managed and analysed population-based primary research data to determine uptake challenges with the WHO recommended IPTp-SP and ITNs.
- Undertook facilitative supervision of two master's and two Dr. of medicine students.
- Published research findings in peer-reviewed journals.
- Presented research findings in seminars and conferences.
- Supported colleague PhD students with study design and data management skills.

Further Training and Certified Professional Development

04.2022	Measles Outbreak Training, WHO, OpenWHO
04.2022	Introduction to Poliomyelitis and the Global Polio Eradication Initiative, WHO, OpenWHO
04.2022	Inequality Monitoring in Immunization, WHO, OpenWhO
11-12.2021	3rd WHO Infodemic Manager Training, World Health Organization, Geneva, Switzerland
05-06.2021	Public Health in Humanitarian Crises 2, John Hopkins University, through Coursera.
04.2020	COVID-19: Tackling the Novel Coronavirus, London School of Hygiene & Tropical Medicine, and the UK Public Health Rapid Support Team.
01.2020	Emergency Triage Assessment Treatment (ETAT) Intensive Course: German Society for Tropical Pediatrics, and International Child Health, Justus-Liebig-Universität, Giessen, Germany.
05-06.2018	Health Technology Assessment: Department of Health Care Management, Technical University of Berlin, Germany.

SERVICE TO THE SCIENTIFIC COMMUNITY

- BMC Pregnancy and Child Health (ISSN: 1471-2393) **2022**
- Pathogens and Global Health (Online ISSN: 2047-7732) **2022**
- *Journal Reviewer*: Heliyon (ISSN 2405-8440) **March 2020**
- *1 of 3 Lead Representatives* of the Heidelberg Institute of Global Health, European Night of Research, Universität Heidelberg **Sep 2019**
- *Course Contributor*: The Disease Control model of the MSc International Health program at the Institute of Global Health, University of Heidelberg, Germany **2018**
- *Field Officer:* Y-PES Ghana – Upper West Region with the *American Peace Corps*, Ghana **2016-2017**
- *Founding Member and Consultant*: Research Web Africa – a grassroot research consortium that provides consultancy and training on field research design and implementation **2015**

INTERNATIONAL SCIENTIFIC CONFERENCES & SUMMITS

- Discussant: World Health Summit: *Science Innovation Policies,* Berlin (Virtual). **25-27. Oct. 2020**
- Abstract Presentation: 38th Annual Meeting of the German Society for Tropical Pediatrics & International Child Health (GTP) in Berlin. **24 – 26.01.2020**
- Poster Presentation: 16th World Congress on Public Health: *Public Health for the Future of Humanity – analysis, advocacy & action*, Italy (Virtual). **12-16. Oct. 2020**
- Abstract Presentation: Annual Interdisciplinary Conference: *Science & Technology for Sustainable Development,* Ghana. **2016**

PROFESSIONAL MEMBERSHIP & AFFILIATIONS

- International Epidemiological Association **Mar 2021**
- Royal Society of Tropical Medicine and Hygiene (RSTMH) **Mar 2021**
- International Society of Global Health **Nov 2020**
- Ghana Public Health Association **Dec 2017**
- Ghana National Association of Teachers (GNAT) **Sept 2015**

AWARDS & HONOURS

- 10,000 Euros grant worth of medical equipment and staff training to Primary Health Care facilities in rural Northern Ghana through the "Weltkirche" support from the Catholic Archdiocese of Freiburg and Wa Catholic Diocese in Ghana. Coordinated through the KUZ of Heidelberg University. **Nov. 2021**
- Recipient of the Helmut Wolf – Prize for the best lecture as an aspiring scientist at the 38th Annual Meeting of the German Society for Tropical Pediatrics & International Child Health (GTP), Berlin. **24 – 26.01.2020**
- Recipient of a full-time KAAD Scholarship Award for PhD in Public Health at the Ruprecht-Karls University, Heidelberg, Germany. **Apr 2017**
- Recipient of Dean's List Semester Award, with GPA: 3.75/4.00, Catholic University College of Ghana, Fiapre, Ghana. **Sep 2011**

Signature:…… **Date:…….**

10 ACKNOWLEDGEMENTS

Every PhD student needs not only a supervisor but a mentor, a research colleague, and an academic father (or mother) who is available, prepared, and envisions the total development and progress of that student as an indelible indicator and a reflection of his/her own footprints on society, because a PhD is 'a global degree'. In 2013 after my bachelor's degree and National Service in Ghana, I applied for the KAAD scholarship to pursue the Heidelberg's MSc.IH program, but the application was not successful. Disappointing and discouraging as this was, I became even more resolved to add a German-issued doctorate certificate and skills to my academic and professional credentials, come rain or shine. I had no idea how I was going to achieve such feat, but I was determined to study in Germany because like many others, I have an insatiable desire and affection for excellence; so, I prioritized Germany over the English-speaking countries for my doctoral studies. By observing and learning from the experiences of other PhD candidates in Ghana and beyond, I was convinced that the PhD journey is not for the faint-hearted, but also not for people with '*two heads*'. Even though I was mentally and psychologically braced for the journey ahead, a retrospective look tells me that no matter how amply prepared (or unprepared) one is, the support and encouragement of the people within and outside the academic circles will usually make an immeasurable difference towards an excellent finish.

After several weeks of virtual midnight searches across the length and breadth of Germany, I finally secured an academic supervisor, Prof. Dr. med. Olaf Müller. He trusted my ability to accomplish the proposed study that many others thought was rather too involving and difficult considering the time, logistics and skills needed. He imbibed in me other crucial skills like financial literacy, precision in scientific writing, coherence and consistency, personal initiative, and team building among other skills, that will shape my career path for life. Lieber Doktorvater, ich bedanke mich ganz herzlich bei Ihnen.

To the entire 'Bergheimer' group – Prof. Dr. Albrecht Jahn, Dr. med. Florian Neuhann, Dr. Claudia Beiersmann, Mrs. Gold-Feuchtmüller Hilde (our ever supportive Administrator); to my colleagues who were about leaving when I joined: Dr. Agbozo Faith, Dr. Barteit Sandra, Dr. Margarida Jorge-Mueller Mendes, Dr. Nuri Nazmun Nahar, Dr. Joy Chuki Mauti, Dr. Dureab Fekri; and my current

colleagues, Qi Chen (Lena), Babak, Caroline, Shahrzad, Astrid, Elvis, Ola, Veronica, Andrew, and Katharina, I thank you all very dearly for providing a pleasant environment within the 'Disease Control in Disadvantaged Populations' and 'Global Health Policies and Systems' research groups, and for making it an 'academic family'. To apl. Prof. Dr. Volker Winkler, Dr. Naasegnibe Kuunibe who provided me with some fundamentals of data management and analyses; I greatly appreciate your inputs and guidance.

Furthermore, I express my deepest heartfelt gratitude to the Katholischer Akademischer Ausländer-Dienst (KAAD) for providing a generous full-time financial support towards my doctoral training. The KAAD has been remarkably supportive, not just financially but also psychosocially and spiritually through the numerous enriching programs, events, and activities which are largely absent from other scholarship programs. You have taken very keen professional and 'parental' interest in monitoring my academic progression and have ensured all the necessary support, even when the program went beyond three years due to the impact of COVID-19 and other factors. From the late KAAD president Prof. Dr. Dr. Eberhard Schockenhoff through Dr. Weber Hermann to Dr. Nora Kalbarczyk, Dr. Marko Kuhn, and my dear Miriam Rossmerkel, I am forever grateful. A noteworthy mention goes to our two wonderful priests, Fr. Prof. Dr. Thomas Eggensprenger and Fr. Prof. Dr. Ulrich Engel, and to all the staffs of KAAD in the administration and other departments. Additionally, I greatly acknowledge the unreserved support from my University Chaplain at the Katholischer Universität Zentrum Heidelberg, Herr Brutscher Markus. Mr. Brutscher's support often came in very handy and timely anytime I was getting overwhelmed by pressure and stress. You did not only support me financially but also counseling, good conversations, tours, museum visits, seminars, and many religious events too; you were more of my closest elder brother to whom I ran for ideas. The thought of your readiness for my problems alone gave me great confidence and peace of mind. Your level of patience and understanding is immeasurable. I can imagine that you would have fought many silent 'wars' on my behalf in my absence. Thank you, Herr Brutscher! To my large KAAD family and Kreuzberg colleagues, especially Dr. Mabel Hoadoeffia, Fr. Michael Lieber Cobb, Miss Felicia Memunatu Sheini, Thania Mara Teixeira Rezende Faria, Flavian (Waanaseti Waiswa), Christopher Omolo, Salama,

Betlehem Mekonnen, Bruks, Ziade, Yeshitla, Fr. Luke Alamezi Oganiru Chibuzo, Fr. Kenneth Onuoha, Mekbib, etc. I remember our fondness!

With nostalgia, I remember the stress and challenges of riding long distances through lonely, snaky, and often risky roads in tracing pregnant women on daily basis during the data collection exercise. The many times my motorbike broke down in the jungle and I had to push for hours under the 40centigrade sun heat and sometimes across streams of rivers; the bumpy journeys that began before dawn; my unforgettable first time encounter with Immigration Officers across the border into Burkina Faso with my lead field assistant; the sad experience of unexpected bowel surgery I had to undergo in the process; the many times I got lost trying to find shorter and safer routes to some hard-to-reach health facilities; and the list goes on! These pregnant women (study participants) kept faith with me and believed that the process was for their good and that of their unborn babies; I say thank you for your seven-months long cooperation. For the many pregnant women who said the 20 Ghana cedis ($3.5) token I gave them for their participation in the study was their miracle for that week; and for those whose birth outcomes were happily eventful by the time we had the focus group discussion of this study, I believe the lessons learnt from this study will improve birth experiences for you and for your future generations. A bundle of gratitude to the very wonderful, understanding, and supportive field assistants who agreed to help me collect the data even though the remunerations were far less than the standard: Zeenat, Dakyaga Francis, Isaac Banique, Inusah, Diana, Callistus, Francis Zellekpier, Joseph Bayor, Rukaya, Dimbie Jamal, and Latif Iddrisu. Many thanks for being my third and fourth eyes in the study facilities. My gratitude to the management and staff of the Ghana Health Service in the Upper West Region and the health facility staffs for their support during the fieldwork. Mr. Basadi Richard and Simon Aabalekuu at the Regional Health Directorate, Mr. Oswald Dachaga of the Wa Municipal Health Directorate, and the district directors of Wa Municipal and Lambussie district, respectively.

My stay in Germany will not have been so sustaining without the support I had from Peter Sauter of Speyer, my very supportive Hausmeister Herr Gerhard Kryzer, Frau Krylow Magdalena in Weingarten, my neighbors Mr. Yakubu Abubakar, Tracy Osei Bonsu, Edmund Yeboah, Solomon Sowah, Abass Mohamed, and my many German friends: Sarah, Mirela, Katharina, Alexander, Anna, Anneliese (Netherland), Julia, Katja, Dr. Barbara, Dr. Claudia Roemer (Berlin), Lisa Rogge,

etc. You all contributed to my smooth integration, a good social life, my average German language skills, and made my stay lighter and worth remembering. Thanks to the International Catholic Community of Heidelberg for the 'home' love. And to the past and present Ghanaian community in and around Heidelberg; thanks for making Heidelberg a home away from home for me.

As for you my dearest family, you know I can never thank you sufficiently! Dear Pammy, you are my 'personal person', you have proven through my doctoral journey what a deeply dependable wife and mother you are. To my dearest mother, Madam Glady A. Dery, and the rest of my family who ably supported my wife and child in my absence (Rev. Fr. William Dun-Dery aka 'Uncle Father', Ing. Felix B. Dun-Dery aka 'CEO,' sister Alice Dery aka 'Director General', Capt. Alex Dun-Dery aka 'Commander', Capt. Elvis Junior Dun-Dery aka 'Prof Pekudu', Gracious Donyin Dun-Dery aka 'Barrister', and all our dear wives and children), Rev. Srs. Joan Dery and Stella Egbu, your prayers, encouragements, and support cannot be forgotten. Fr. Willie, I have not forgotten your stressful journey all the way to visit me in Germany just to offer me encouragement and assurance that you are always there as the buffer which absorbs the shocks of the family, ably supported by your lieutenant, Ing. Felix. You have no co-equals at all! Not forgetting my in-laws; Mr. & Mrs. Kuusogre Amatus, Amanda, Jessica, Richard, and Mabel. You gave me cause to gain some peace of mind when I was worried-sick about the safety and up-keep of my infant boy and his mother. Much gratitude to my lovely son, Senior Allan Mwinkum Dun-Dery aka 'Allan Car', for whom I wake up midnights in search for opportunities to give him a better upbringing.

I cannot forget to acknowledge the tremendous efforts from my MPhil supervisor and mentor Prof. Dr. med. Juventus B. Ziem, my internal examiner (and KAAD alumnus), Dr. Martin N. Adokiya, and my bachelor's supervisor Dr. Henry Ofosu Addo, who all inspired me greatly to join academia.

To all who pushed me directly and indirectly towards or within this path; for those who thought of me as a competitor and a comparing factor for their progress; for those who refused me any assistance for which reason I had to find options to survive, it all turned out to be a worthwhile push or pull, and I owe it to you too.

Above all, you the Almighty God deserve all praise for how far you have brought me!

EIDESSTATTLICHE VERSICHERUNG

1. Bei der eingereichten Dissertation zu dem Thema *Malaria Control among Pregnant Women in Ghana: A mixed-methods study on the Uptake of Intermittent Preventive Treatment and Insecticide Treated Mosquito Nets* handelt es sich um meine eigenständig erbrachte Leistung.

2. Ich habe nur die angegebenen Quellen und Hilfsmittel benutzt und mich keiner unzulässigen Hilfe Dritter bedient. Insbesondere habe ich wörtlich oder sinngemäß aus anderen Werken übernommene Inhalte als solche kenntlich gemacht.

3. Die Arbeit oder Teile davon habe ich bislang nicht an einer Hochschule des In- oder Auslands als Bestandteil einer Prüfungs- oder Qualifikationsleistung vorgelegt.

4. Die Richtigkeit der vorstehenden Erklärungen bestätige ich.

5. Die Bedeutung der eidesstattlichen Versicherung und die strafrechtlichen Folgen einer unrichtigen oder unvollständigen eidesstattlichen Versicherung sind mir bekannt. Ich versichere an Eides statt, dass ich nach bestem Wissen die reine Wahrheit erklärt und nichts verschwiegen habe.

Ort und Datum: …… Unterschrift: …….