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THE IMPACT OF MALARIA AND ITS COMPLICATION FOR BOTH MATERNAL AND FETUS IN AFRICA.

Master thesis (Medicine)

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Summary

Malaria in pregnancy is a significant public health issue in the world. It affects approximately twenty-five million pregnant women annually. There are various wide-ranging effects linked to malaria that affect the well-being of the mother as well as the newborn. This study aimed to investigate the impact of malaria and its complication for both maternal and fetuses in Africa. The study found that global initiatives have spurred the fight against malaria. In the past twenty years, significant progress has been recorded in discovering anti-malarial drugs. The systematic review conducted by the current study revealed that the frequency or malaria prevalence among expectant mothers in Africa is relatively higher than in the general population. Therefore, there is a need to strengthen the existing control and prevention measures of malaria infection, for example, health education regarding the adoption and application of IRS in controlling malaria vector and timely diagnosis as well as treatment of malaria in pregnant women in Africa. This study undertook content analysis of different literature existing about malaria to understand the patterns of infection, treatment behaviors and other government interventions. Some of these studies incorporated data on patient adherence and drug quality. The findings of these studies present elaborate insights and assistance that characterize different patterns of effectiveness based on other regions of Africa. This study concludes that three or more doses of IPTp-SP administered to pregnant women in sub-Saharan Africa result in decreased risks of adverse outcomes of malaria during pregnancy, such as LBW, as it increases birth weight more than when a standard 2-dose regimen is used. Control and management of malaria is an essential strategy in endemic countries, especially for the timely diagnosis and effective treatment of malaria cases. This study recommends an urgent need to strengthen the existing control and prevention measures, policies targeting interventions, and monitoring of resistance to anti-malarial drugs and make it a policy tool to combat malaria.

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Conflict Of Interest

No conflict of interest in this study

Permission Issued by the Ethics Committee

The author received permission by LUHS ethics committee to perform this study, the permission code is BEC-MF-324. Certificate has been attached on the annex section of this paper.

Abbreviation List

ACTs	Artemisinin-based combination therapies
ANC	Antenatal
CSA	Chondroitin Sulphate A
DHA-PQ	dihydroartemisinin-piperaquine
DP	dihydroartemisinin-piperaquine
FMH	Federal Minster of Health
G6PD	glucose-6-phosphate dehydrogenase
HIV	Human Immunodeficiency Virus
IRS	Indoor residual spraying
ITSs	Insecticide-treated mosquito nets
IPTp	Intermittent preventive treatment for pregnant women
JBI	Joanna Brigg's Institute
LAMP	Loop-mediated isothermal amplification
LBW	Low Birth Weight
PCR	Polymerase chain reaction
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RDT	Rapid diagnostic test
SP	sulphadoxine-pyrimethamine
WHO	World Health Organization

Introduction

Malaria in pregnancy is a significant public health issue in the world. It affects approximately twenty-five million pregnant women annually. These figures include low and high malaria-endemic regions (World Health Organization, 2021, p.1). Studies have shown that pregnancy is a period where women are more vulnerable to opportunistic diseases. Nevertheless, some people acquire immunity, such as individuals who reside in high-malaria-prevalence areas [24]. Malaria during pregnancy is one of the major public health issues in sub-Saharan Africa (WHO, 2013). Therefore, *Plasmodium falciparum*, the leading cause of malaria during pregnancy, is one of the significant health problems in public health in sub-Saharan Africa (WHO, 2021). Pregnant women are especially vulnerable to the infection of malaria. They do not have strong immunity and, therefore, are exposed to severe malaria that may require emergency treatment. Some of the expected consequences of malaria during pregnancy is pregnancy loss. Implications to the mother infected with malaria in semi-immune women include anemia and stillbirth. Restriction of fetal growth and premature delivery are other consequences. Some preventive measures that have been used against malaria entail intermittent preventive treatment and sleeping inside mosquito nets in some African settings. It is important to note that timely management of malaria using artemisinin combination treatments (ACTs) and parenteral artemisinins when a woman is in her second and third trimesters of the pregnancy is essential in combating malaria among pregnant women. Similarly, monitoring the safety of anti-malarial drugs and understanding how pharmacokinetics is exceptionally fundamental in the pregnancy characterized by maternal physiology that is altered or risks of developing fetus. Most African countries have adopted and embraced approaches geared toward eliminating malaria as part of their national agenda. They focus on underserved and vulnerable populations such as infants and pregnant women.

It is important to note that has been tremendous progress in reducing the prevalence of malaria in Africa in the past twenty years. Some scholars who have conducted a comparative study between Africa and other regions of the world, such as the Asia-Pacific region among pregnant women have found that malaria in pregnancy between the two regions is different. For instance, many women in Africa are more vulnerable to malaria in transmission settings that are considered to be highly heterogeneous. It is also important to add that most African women do not have any or little background immunity against malaria. Consequently, each malarial infection is potentially fatal not just to pregnant women but also to their fetuses

In recent years, the global burden of malaria has plummeted. However, 40% of the population in the world is still at risk of malaria infection. Similarly, approximately 400,000 people worldwide die of malaria every year. For instance, in India, about 90% of the population lives in areas with malaria transmissions. Two-thirds and a third of infections in this country are caused by *Plasmodium falciparum* and *P. vivax*, respectively. Over 13 million people are thought to be infected with malaria worldwide, and over 25,000 people succumb to the disease each year (WHO, 2016). Yearly estimated, over 30 million women become pregnant in malaria-endemic countries, particularly sub-Saharan Africa, where high transmission and malaria infection during pregnancy can be dangerous. Due to immune depression of Pregnant women, therefore, pregnant women are particularly more susceptible to being infected by malaria, which can lead disastrous consequences to both maternal and fetus, and such consequences possibly could be maternal anemia, stillbirth, prenatal mortality, preterm delivery, spontaneous miscarriage, low birth weight, and foetal growth retardation. The susceptibility of pregnant women to malaria is linked to immunological changes that take place during pregnancy. It is also associated with the unique P. *falciparum* subset of parasites as far as the sequester in maternal blood spaces in the placenta is concerned. Parasites in the placenta, in the case of placental malaria, find it easy to escape clearance by the immune system. They avoid being filtrated by the spleen. Similarly, *P. falciparum* parasites possess a red cell-surfaced protein called VAR2CSA. It adheres to Chondroitin Sulphate A (CSA), a placental receptor [33]. Studies have connected placental malaria protein release and antibodies to VAR2CSA, which have been associated to poor delivery outcomes for expectant mothers. This study investigates the landmark achieved so far in dealing with malaria among pregnant women, being that their susceptibility affects the health of both the foetus and the mother.

Aim and Objectives

Aim:

To evaluate the prevalence and impact of malaria and its complication for both maternal and foetus in Africa in order to suggest relevant fights against the problem.

Objectives :

- To investigate the frequency/incidence of malaria in pregnant women in Africa.
- To find out the clinical consequences of malaria in pregnant women and foetus.
- To evaluate the efficiency of current treatment of malaria in pregnancy.

1 Literature Review

1.1 Frequency of Malaria in Pregnant Women in Africa

Nigeria is the nation in Africa with the highest rate of malaria mortality, according to the World Health Organization [12]. Democratic Republic of the Congo comes in second with 12.6%, followed by Tanzania with 4.1%, and Niger with 3.9%. In contrast, approximately 75% of Ethiopia's land is plagued with malaria, which is a matter for concern [5]. As a result, according to the Federal Minister of Health (FMH) report of Ethiopia, more than 70% of the country's population lives in locations where malaria is common, placing them at a high risk of getting the disease. Averagely, 60-70% and 30% of all malaria cases have been caused by *P. falciparum* and *P. vivax,* respectively. The Federal Democratic Republic of Ethiopia [13] notes that An. phronesis, An. funestus, and An. nili are the primary and secondary malaria vectors in Africa as a whole, not just in Ethiopia.

As stated before, malaria infection is a serious public health issue in African countries in afsubtropical and tropical regions. Pregnant women and their fetuses face a significant risk of malaria infection. It has been estimated in yearly reports that over 25 million pregnant women in Africa are at risk of malaria infection. Over 10,000 pregnancies are lost each year in Sub-Saharan Africa due to malaria infections, according to research by Tegegne et al. [32]. According to a World Health Organization report published in 2018, malaria infection during pregnancy causes approximately 20% of stillbirths each year in Sub-Saharan Africa.

However, there is no adequate compiled data from various studies regarding the relationship between malaria and LBW in Africa. Available data indicate that sub-Saharan Africa has a high prevalence of malaria compared to other parts of the content. Therefore, information from this study may be significant not just for pregnant women in the region but also for other policy-makers and stakeholders.

Different studies have been conducted to establish malaria prevalence among pregnant women in Africa. However, there is a lot of inconsistent and disparity in the findings presented by these studies. Further, there are not enough systematic reviews or meta-analyses presenting the malaria prevalence rate among pregnant women in Africa. Therefore, this study is meant to fill this gap by evaluating the impact of malaria and its complication for both maternal and foetus in

Africa. This study may help implement control and preventive measures for malaria in not just pregnant women but other sections of the population.

Furthermore, health system factors are strongly related to anti-malarial AmE. Many literature agree that the human resource capacity of healthcare systems and access to healthcare by members of the community influence not just which drugs are prescribed and used. Therefore, the low access that the African population in rural areas have to healthcare indicates that not so many people will reach the healthcare system. As a consequence, malaria infection among pregnant women will not be detected, treated, or get treatment from any source. However, getting treatment from any source may result in difficulty recording the type of malaria the individual is suffering from, the quality of drugs, and the dosage of drugs given to the individual. Thus it may not be part of the official statistics of the healthcare system. Other health system factors that influence malaria treatment in Africa include affordability, acceptability, and availability of antimalarial drugs.

1.2 Clinical Consequences of Malaria in Pregnant Women and Foetus

Placental malaria results in negative consequences for pregnant women and their babies. Fetal loss, low birth weight (LBW), and severe maternal anaemia are some common consequences. For instance, studies have estimated that between 60,000 and 360,000 infants die yearly in Africa because of LBW. As previously mentioned, LBW and placental malaria are closely related (Mohammed et al., 2013) [26]. Because of the existence of parasites that are resistant to the medication, the WHO-recommended IPTp-SP treatment is no longer effective in East and Southern Africa Mikomangwa et al. (2019) [25]. Pregnant women with malaria are more likely to have preterm birth, stillbirth, and miscarriage, according to Tegegne et al. (2019) [32]. Fig. 1 below summarizes the different effects of malaria on pregnant women in Africa. It is derived from the research by Kimbi et al, (2014) [21] in which 443 respondents were interviewed, 99% of whom had heard of malaria.

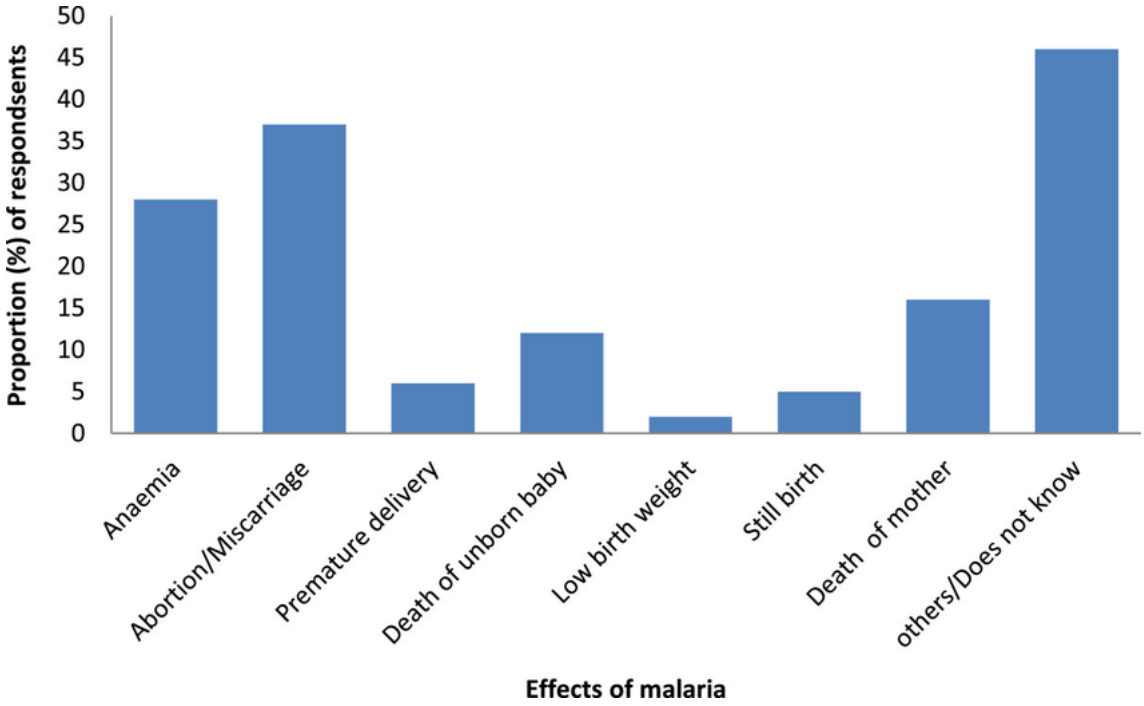

Fig. 1: Effects of Malaria on pregnant women in Africa

Source: Kimbi et al, (2014) [21].

Mohammed et al. (2013) [26] conducted a case-control study in Central Sudan to determine the relationship between LBW and submicroscopic *P. falciparum* infection. Central Sudan is an area characterized by the unstable transmission of malaria. The control group involved women without LBW deliveries, and the intervention group were women with LBW deliveries. The study found that the intervention group has a high prevalence of submicroscopic malaria infection at 27.6% compared to 7% of the control group. The study used multivariate analysis, revealing that malaria infection in the placenta was insignificantly linked to LBW. In contrast, a combination of submicroscopic infections significantly determined the infection.

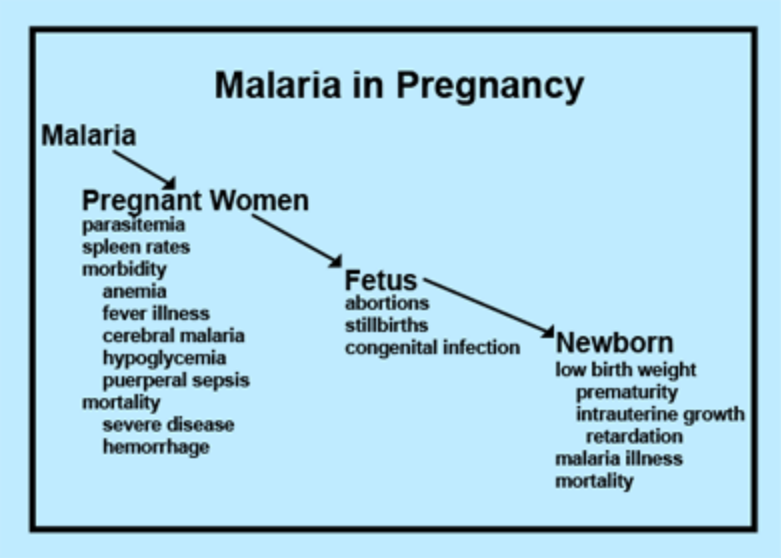

Fig. 3: Burden faced by pregnant women during malaria.

Source: Author

1.3 Efficiency of Current Treatment of Malaria

A cohort study among pregnant HIV-negative women in Dar-es-Salaam, Tanzania, was used in a different study by Kalinjuma et al. (2020) to determine the determinants affecting submicroscopic placental malaria and how it affects adverse outcomes in pregnant women. For instance, the study found that women who did not use mosquito coils, fumigation, or mosquito nets had a higher risk of getting malaria, especially submicroscopic placental malaria, than women who employed malaria prevention approaches such as using mosquito coils, fumigation, or mosquito nets.

1.4 Current Malaria Therapies

Global initiatives have spurred the fight against malaria. In the past twenty years, major progress has been recorded in discovering antimalarial drugs. However, malaria treatment has largely been dominated by four fundamental classifications of drugs throughout the 20th century. The discovery of antimalarial drugs with emerging targets is an important aspect since *Plasmodium* strains in Africa have resisted the available drugs. This resistance threatens the effectiveness of the available drugs used to treat malaria. These four classifications of antimalarial drugs can either be used to treat or cure malaria. Fig. 2 below summarizes different therapies for malaria, their recommendation, and dosage form as well as strength in pregnant women in Africa.

Condition	Recommendation	Dosage Form	Strength
Uncomplicated malaria (First-line treatment)	Artemether-lumefantrine	Tablet	20 mg Artemether + 120 mg Lumefantrine
Uncomplicated malaria (Second-line treatment)	Quinine	Tablet	200 mg 300 mg
Severe and complicated malaria Pre-referral treatment	Artemether injection	Injection	Adult: 80 mg/ml Pediatric: 20 mg/ml
	Artesunate injection	Injection	60 mg/1 ml ampoule
	Artesunate rectal caps	Suppositories	100 mg 400 mg
IV/IM phase	Quinine	Injection (IV or IM)	300 mg/1 ml ampoule 600 mg/2 ml ampoule
Continuation phase	Quinine	Tablet	200 mg 300 mg
Prevention of malaria in pregnancy	Intermittent Preventive Treatment (IPTp) using SP	Tablet	Sulphadoxine 500 mg; Pyrimethamine 25 mg
Treatment of uncomplicated malaria in pregnancy	Trimester 1: Quinine	Tablet	300 mg
	Trimester 2 & 3: Quinine or	Tablet	300 mg
	Artemether-Lumefantrine	Tablet	20 mg Artemether + 120 mg Lumefantrine
Treatment of complicated malaria in pregnancy	The treatment of pregnant women with severe malaria shall be the same as the treatment of severe malaria in the general population.		

Fig. 2: Different therapies for malaria, their recommendation, and dosage form as well as strength in pregnant women in Africa.

Source: El-Tawdy et al. (2018) [11]

1.5 Quinoline derivatives

Quinoline family members entail primaquine, mefloquine, and chloroquine. However, studies have found that Chloroquine (CQ) is the most effective antimalarial drug, especially 4-aminoquinoline. This success is in line with its efficacy, toxicity, and cost. However, the use of CQ to treat malaria has been adversely impacted by the antimalarial drug resistance in Plasmodium strains in many parts of the world (El-Tawdy et al., 2018) [11]. It has been discovered that Quinoline derivatives work by stopping blood parasites from digesting heme. In particular, CQ hinders the parasite's feeding vacuole from successfully polymerizing hemozoin from heme, which causes its harmful effects and accumulation (Pereira et al., 2021) [29]. Even though P. falciparum suppresses resistance to CQ in the majority of malaria-endemic areas, P. vivax continually remained susceptible to this medication and therapy.

Another study conducted by Chu and White (2021) [9] found that Mefloquine (MQ) is a derivative agent of quinine sensitive to all the blood stages of the infections of *P. vivax* and

P. *falciparum*. Aktas et al. (2020) further add that the action mechanism of MQ is still misunderstood. Nonetheless, it is considered effective to treat malaria by acting by preventing the processes of haemoglobin endocytosis from taking place in *Plasmodium* parasites. It is important to note that MQ and CQ are quinoline derivatives with sensitive strains which can successfully be used in clinical cures to do away with blood-stage parasites. Further, some studies have established why quinoline drugs have been resisted. According to Zomuanpuii et al. (2020) [46], the primary reason for the resistance of quinoline drugs is when the parasite transporter proteins mutate.

Much as Quinoline derivatives have been established as effective antimalarial drugs, caution must be exercised while administering them on pregnant women. A study by Yefet, Schwartz, Chazan, Salim, Romano, & Nachum, (2018) [43] investigated the extent of safety of this drug on pregnant women. It was found that it posed no negative outcomes in pregnancy, though a recommendation was made that there must be caution while administering it since as a first-line therapy, especially in the first trimester. Another study by Acar, Keskin-Arslan, Erol-Coskun, Kaya-Temiz, & Kaplan (2019) [1]agreed with Yefet, et al. (2018) [43] that exposure to quinoline does not pose any adverse effects to the pregnancy outcomes. The significantly decreased live birth rates and elective terminations are not necessarily as a result of its effect but could be scares from misperceived teratogenic risks.

Because it is suitable for all pregnancies in all trimesters, the WHO recommends sulfadoxine/pyrimethamine as the first line treatment for pregnant women [16]. This medication is suitable for all women residing in malaria-prone areas of Africa and is advised for intermittent preventive treatment (IPT). IPT is the chemoprevention for malaria that was welcomed as malaria treatment policy following the realization that malaria parasites developed resistance to the existing chloroquine mediated prophylaxis. The World Health Organization, in 2004, report on strategic framework for malaria prevention and control during pregnancy in the African region. Due to this medication's lengthy half-life, which allows it to be effective during each scheduled intermittent dose and provide prophylactic coverage for the intervening weeks [16], the WHO approved it. Therefore, it was described as a curative procedure carried out at desired intervals during pregnancy, whether or not an infection is present. However, it is not recommended for mothers under HIV drugs that contain cotrimoxazole prophylaxis because the two drugs can potentially interact. Moreover, there have been several reports of resistance towards the drug, though it still remains one of the most preferred forms of treatment for pregnant women.

Hence, mefloquine is suggested as the drug that can cut across in helping women in any condition. This drug was first investigated for its effect on pregnant women in the 90s. It was originally developed by the US military to prevent malaria among the travelers. 4-methanolquinoline stems from the family of quinine and has a long elimination half-life (two to four weeks), just like sulfadoxine-pyrimethamine. The appropriate dosing for pregnant women should be monthly. When this drug was investigated for its role on still births back in the 90s, there was not strong evidence linking the two. Hence, Gonzalez (2014) concluded that the drug posed no risk to the foetus or the mother when used during pregnancy. The only concern with this drug is its mild dose-related transient side effects like nausea, vomiting, and dizziness. Among pregnant women, vomiting and dizziness are the most common side effects. This is so following the revelation by the Beninese study which was carried on pregnant women Briand, Bottero, Noël, Masse, Cordel, Guerra, ... & Cot (2009) [6]. Fortunately, malaria parasites are only reported to be resistant in areas like Thailand, with no cases reported in Arica so far. In the research by [4], it was found that as other drugs like chloroquine and sulfadoxine-pyrimethamine showed some dramatic decreased efficacy over time, mefloquine remained stable over time in Sothern Benin. This alleyed the fears that perhaps plasmodium resistance to the drug in Africa was being common. Mefloquine demonstrated efficiency of over 97.5% while chloroquine demonstrated failure rates as high as 85.7% and SP as high as 50% [4]. This made it possible to reconsider using quinine and chloroquine as the only antimalarial medications. This was especially true given that there was no access to the alternate treatment using arthemeter-lumefantrine.

1.6 Atovaquone

According to Pereira [29], atovaquone is a different type of antimalarial medication that actively hinders the functioning of Plasmodium liver and blood stages but not hypnozoites or gametocytes. The only medication now utilized in clinical settings to suppress plasmodium is atovaquoneThe *Plasmodium* mitochondria, Cyt *bc1*, are essential in the chain of electron transport and, consequently, the survival of a parasite. Therefore, atovaquone inhibits this process. Studies have shown that the drug is combined with proguanil to treat uncomplicated malaria as an agent of prophylactic (36). However, clinical resistance to this drug can be traced to cyt *bc1* mutations.

The WHO recommendations for malaria chemoprevention among children and pregnant women [34] investigated approaches used in preventing and controlling malaria. They have found that the most substantive control and prevention measures of malaria include seasonal malaria

chemoprevention (SMC), the rapid diagnostic test (RDT), diagnosis using malaria microscopy, treatment of pregnant women using IPTp-SP, indoor residual spraying (IRS), insecticide-treated mosquito nets (ITNs), and artemisinin-based combination therapies (ACTs (10) (World Health Organization, & Center for Disease Control, 2010) [41]

1.7 Management of Malaria in Pregnancy

1.7.1 Prevention

The WHO recommended three prolonged strategies for preventing malaria among pregnant African women. These strategies include intermittent preventive treatment (IPTp) and insecticide-treated nets (ITNs); case management which involves timely treatment of malaria using highly effective drugs; and a full treatment course of drugs used to treat malaria regularly at antenatal visits, which is most often one month apart.

1.7.2 Intermittent Preventive Treatment (IPTp) in pregnancy

IPTp is currently recommended to be used only in Africa in combination with sulphadoxine-pyrimethamine (SP). A study by Kayentao et al. (2013) [20] found that three doses of IPTp were more effective than two doses. It also concludes that IPTp remains to be the most effective antimalarial against LBW as well as anaemia. However, the study also established a high resistance to SP in Southern and Eastern Africa.

Mefloquine, combined with chloroquine and azithromycin, has been found in recent years to be effective in preventing malaria among pregnant women. For instance, mefloquine decreases the prevalence of the parasite at delivery. However, it was poorly tolerated. It is also important to note that the trial of chloroquine and azithromycin was halted because they failed to present clear benefits over SP (Rijken et al., 2012) [30]. Other studies have revealed that dihydroartemisinin-piperaquine (DHA-PQ) may effectively and successfully replace SP. Its trials have been carried out in Indonesia, and it will likely provide reliable solutions to Africa as far as the fight against malaria is concerned. However, there is inadequate information on the efficacy of IPTp in countries with a lower rate of malaria transmission (Kayentao et al., 2013) [20]. Like any drug, SP-IPTp has its challenges, including low uptake levels and a lack of evidence on its efficacy in dealing with *P. vivax*.

IST has been taunted to replace IPTp. An RDT is performed at each antenatal visit using this approach. Women who test positive are administered an effective antimalarial, particularly ACT. Studies have established that RTDs currently have low sensitivity. They have also found that IST has been more effective than IPTp in curing and preventing malaria and its adverse outcome among pregnant women in Africa (Rijken et al., 2012) [30].

1.7.3 Insecticide-Treated Nets (ITNs) and Indoor Residual Spraying

Evidence from studies conducted in Africa reveals that it effectively prevents malaria and decreases LBW and other adverse outcomes of malaria during pregnancy. ITNs are not just cheap but also effective in preventing malaria among pregnant women in Africa. On the other hand, indoor residual spraying is majorly used in different parts of Africa. However, there is no tangible evidence that links its impact on pregnancy.

1.7.4 Severe Malaria in Pregnancy

When a pregnant woman exhibits severe malaria, the main objective and focus should be saving her life. Studies have shown that parenteral artesunate is the recommended antimalarial for treating severe malaria (Kapisi et al., 2017). Once the life has been saved and the patient recovered, appropriate oral medication can be administered to continue the treatment. It is important to note that pregnant women are most vulnerable to high blood sugar levels and hypoglycaemia, and they need to be closely monitored.

1.7.5 Artemisinin-based Combination Therapies (ACTs)

Pregnant women are vulnerable to severe consequences of malaria infection, especially in the first trimester. If not handled properly, they may experience serious cases of maternal anaemia, low birthweight neonates, and fetal loss (Slutsker & Leke, 2023) [31]. Malaria in the second and the third trimester may not require as much attention as in the first trimester because in the first trimester, some treatments may lead to more serious consequences to the foetus and the mother. It is, therefore, imperative to alienate some treatments which are not appropriate during the first trimester but are increasingly being effective in the consecutive trimesters. One of the therapies that have been recommended by WHO during this period (second and third trimesters) is the use of artemisinin-based combination therapies (ACTs). This drug is not recommended for use in the

first trimester of pregnancy due to low tolerance of ATCs by the mothers. ATCs have been proven to result in serious embryolethal and teratogenic effect when used in the first trimester when it was tried in other animals.

Four different ACTS are recommended by the World Health Organization, especially in the second and third trimesters, namely; dihydroartemisinin-piperaquine (DHA-PQ), mefloquine-artesunate, amodiaquine-artesunate, and artemether-lumefantrine. Studies have established that all these drugs are effective, with more than 95% efficacy (WHO, 2016). Similarly, the drugs do not result in adverse outcomes of malaria among pregnant women. Consequently, pregnant women have recommended ACTs as a first-time antimalarial treatment. On the other hand, chloroquine is largely the most effective drug for treating vivax malaria in different parts of the world in the same way as ACTs and parenteral artesunate. However, primaquine is dis-recommended for use among pregnant women because of its risk of severe haemolysis in individuals with insufficient glucose-6-phosphate dehydrogenase (G6PD). It is important to state that pregnant women suffering from malaria may need suppressive treatment using chloroquine until they deliver. Before primaquine is prescribed for lactating women, it is recommended that the G6PD of the infants is tested since primaquine finds its way to the breast mill, albeit in small amounts (WHO, 2016).

1.7.6 Antimalarials' Pharmacokinetics during Pregnancy

Different studies in recent years have investigated the pharmacokinetics of antimalarials among pregnant women. The objective of such studies is to find out whether the adjustment of doses is necessary (Dellicour et al., 2017). Some evidence has suggested that there is a need to extend the duration of the treatment when using artemether-lumefantrine. However, there are no recommendations on dose adjustment at the moment. Further, insufficient data support dose adjustment for antimalarials among pregnant women.

Many studies have recommended several practices for special groups, such as pregnant women with HIV. HIV infection makes pregnant women vulnerable to malaria. Studies have revealed that IPTp should not be administered to HIV-infected pregnant women prescribed co-trimoxazole (Gonzalez et al., 2014) [15]. The role of co-trimoxazole is to prevent HIV-infected women from getting opportunistic diseases. The use of IPTp makes HIV-infected pregnant women vulnerable to severe skin reactions.

2 Research Methodology and Methods

2.1 Search Strategy

This is a systematic review of the impact of malaria and its complication for both maternal and foetus in Africa. It was organized and reported in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The researcher searched for articles from electronic bibliographic databases such as Science Direct, Google Scholar, and PubMed. The researcher further identified the studies conducted not more than fifteen years ago

on the impact of malaria and its complication for both maternal and foetus in Africa. The search terms used include the prevalence of malaria during pregnancy, pregnant women and malaria, malaria in Africa, the impact of malaria, malaria outcomes, malaria in pregnant women, pregnant women and foetus, malaria treatment for pregnant women, and approaches to malaria treatment. These terms were combined with operators such as "OR" or "AND".

2.2 Eligibility Criteria

Eligibility criteria in this study entailed exclusion and inclusion criteria. Regarding inclusion criteria, the study only included peer-reviewed journals and articles published on the impact, treatment, and prevalence of malaria and its complication for both maternal and foetus in Africa. It only included studies published in English with clear and minimum information regarding the sample size and the status of malaria infection. The studies must have taken place in Africa and within the period of fifteen years. These aspects helped the study narrow down on searching for information on the impact of malaria and its complication for both maternal and foetus in Africa. The study also included studies in which malaria was diagnosed using polymerase chain, diagnostic test and microscopy. Most of the articles chosen for analysis were those that adopted cross-sectional study designs. Cross-sectional study design was important because exposure to malaria happens over and over and may reinfect someone even after treatment. Hence, the series of treatment and exposure was very appropriate for providing data about the trend of malaria among the chosen respondents. On the other hand, the researcher excluded studies conducted in other languages apart from English, those conducted more than fifteen years ago, and those not conducted in Africa.

2.3 Quality Assessment and Search Methods

In this research, I used search terms to independently search Science Direct, Google Scholar, and PubMed on articles and studies done on the impact of malaria and its complication for both maternal and foetus in Africa using keywords as stated above. Title of the studies or abstracts were used to screen the searched articles. The researcher screened 32 for eligibility after excluding the duplicates. Consequently, 12 articles were selected for evaluation in the study. Munn et al. (2015, p. 149) [27] offer methodological guidance on systematic review using a critical appraisal checklist by Joana Brigg's Institute (JBI). The study used this critical appraisal checklist to check malaria prevalence among pregnant women in Africa.

2.4 Data Extraction

Microsoft word tables has been used as a tool for data extraction. It documented evidence on the author's name, the year of publication, sample size, study design, and the results of the study. Other articles were also secluded for their reports on the prevalence of malaria among pregnant women in Africa. The tables are shown below and documents the results of special articles that were carefully chosen for analysis.

2.5 Data Analysis

Articles that were eligible for inclusion were entered into Microsoft Word tables and used for analysis. The first six articles were analyzed for their trend on reporting about malaria prevalent among pregnant women in specific African countries which have been reported to rank high in malaria infection. The rest of the four articles were analyzed for their reporting on malaria prevalence in the Sub-Saharan Africa while the next two were analyzes for their report on malaria infection in the rest of African (northern Africa). For the sub-Saharan African countries, two countries were chosen to represent East Africa and another, Southern Africa. West Africa and Central Africa were left out because they already dominate the top infected countries in the previous table. The inclusion criterion for any country relied on the WHO report on the prevalence of malaria in these specific countries. So, in each region, the country that was ranked the highest in malaria infection directly qualified for inclusion. If the country is already chosen in the previous category, the number two in the ranking follows. Hence, for East Africa, Kenya was chosen because Uganda could not be included since it topped in the previous table. The summary of their findings was recorded in an excel table to have a clear picture of where the direction of malaria infection is pointing. For Southern African case, Zambia came in handy because Mozambique was already considered in the previous section. Since this was a critical review of already existing literature, the study did not employ any technical software to analyze the data. As long as the article qualified in the eligibility criteria, the findings were regraded as reliable and worthy to rely on.

3 Results and their Discussion

Prevalence of malaria among pregnant women

This research sought to understand the prevalence of malaria among pregnant women in Africa in order to give appropriate recommendations following the findings. Data about malaria infection in Africa as a continent is quite scarce. However, individual countries have been studied

on their performance as far as talking malaria infection among pregnant women is concerned. Hence, the study focused on studying the 6 countries which WHO documents as the most malaria endemic in Africa. These countries include: Nigeria (with infection rate of 26.8%), the Democratic Republic of the Congo (with infection rate of 12%), Uganda (with infection rate of 5.4%), Mozambique (with infection rate of 4.2%), Angola (with infection rate of 3.4%) and Burkina Faso (with infection rate of 3.4%). Ethiopia was of special interest because the larger percentage of its land (75%) is documented to be malaria prone. The following table summarizes the results of the findings by different researchers in every sample country.

Author	Year of publication	Country of study	Study design	Sample size	Findings
Tegegne et al [32]	2009	Ethiopia	Systematic review	7 articles out of 10207	12.72% of women were affected with malaria with confidence interval of 95%
Agomo, [2]	2009	Nigeria	Cross sectional stud	1,084 pregnant women	7.7% at 95% confidence interval
Valente, Campo et al. [35]	2011	Angola	cross-sectional study	567 pregnant Angolan women living in Luanda	One in five had risk of plasmodium infection
Wafula et al. [37]	2021	Uganda	Cross sectional study	2062 from health facilties in	3.1 to 50.0% women are at risk of infection

				Iganga, Luuka and Buyende in eastern Uganda	
Lingan,. et al. [22]	2022	Burkina Faso	Cross sectional	1067 pregnant women	16.1% had microscopy malarial infection
Wumba, et al. [42]	2015	Democratic Republic of Congo	prospective study	332 pregnant women	74.1% (246/332) could be detected to have plasmodium infection

Table 1: malaria infection in the six most malaria prone countries in Africa.

Eastern and Southern Africa is one of the Sub-Saharan Africa regions experiencing heavy burdens of malaria. The following table samples two countries form the region and reports on the malaria trend across the region. most of the studies considered were cross sectional studies taking place in different locations of a give country.

Author	Year of publication	Country of study	Study design	Sample size	Findings
Okoyo et al. [28] .	2021	Kenya	Cross sectional	1,128 respondents	34.1% at 95% Confidence Interval
Waiswa et al. [38]	2022	Kenya	cross-sectional study	304 asymptomatic pregnant women	74 asymptomatic pregnant women out of 304 (24.34% at a confidence level of 95%) were detected to be infected
Chaponda et al. [8]	(2015).	Zambia	Cross sectional study	1079 pregnant women	31.8 % at confidence level of 95 %
Kamuliwo et al. [18]	(2015).	Zambia	Critical review	N/A	1.5% of the total number of malaria cases reported in

					Zambia between 2009 and 2014 are affecting pregnant women

Author	Year of publication	Country of study	Study design	Sample size	Findings
World Health Organization [40]	2019	Algeria	Annual report	NA	0 malaria cases since 2014
Centre for Disease Control and Prevention [7]	2014	Egypt	Phenomenological study	NA	Last transmitted malaria was in 1998

Finally, WHO suggests that the burden of malaria is least felt in the northern regions of Africa. Hence, it was necessary to get a picture of two countries in the Northern African regions. For the purpose of reliable data, this study considered Egypt and Algeria. These regions are considered the least malaria infested in North Africa.

From the above data, it is evident that pregnant women in the sub-Saharan Africa still have to endure serious burdens of malaria.

From the above data, especially in the first table, it is notable that malaria infection among pregnant women in Africa still stands at a percentage higher than 20%. Nigeria is mentioned as recording the highest cases of malaria among pregnant women in Africa, followed by DRC. Hence, it is imperative to look at the demographic factors that may contribute to such a situation in Nigeria. Agomo, Oyibo, Anorlu, & Agomo (2009) [2] the prevalence is higher among pregnant women

under the age of 20. Also, a quarter of malaria cases are coming from Nigeria, making over 150 million cases a concern in Nigeria. One of the reasons pointed for the increased cases of malaria among pregnant women in Nigeria is the decreased use of insecticide-treated bed nets (ITNs). This is so even if WHO has recommended that the use of INTs significantly cuts down the infection of malaria, whether among pregnant women or any other person living in malaria-infested area. According to Agomo et al. (2009) [2], only 30% of pregnant women sleep under treated nets annually. Furthermore, Nigeria is lagging behind in the effort of spreading the good information about malaria and its prevention. For this matter, many people despise effective preventive measures under the guise of their ineffectiveness.

Moreover, Ethiopia presents a peculiar case being that its land is over 75% malaria prone. The peer-reviewed article by (Tegegne, Asmelash, Ambachew, Eshetie, et.al)(2009) [32] puts this country after DRC in terms of malaria, that affects pregnant women. Ethiopian women are affected by malaria differently according to their geographic locations. For instance, the highest records are in Adama, Central Ethiopia (44.6%), and the lowest in Addis Zemen Health Center (2.8%). These differences occur as a result of varied climatic conditions, rainfall patterns, and applied prevention control methods. The biggest variation lies in the differences in the way people adopt control measures like adaptation of artemisinin-based combination therapies (ACTs), long-lasting insecticide-treated nets (LLIN), insecticide residual spraying (IRS), and early testing at the community levels. Therefore, Ethiopia's case is also a result of poor control measures by the people who are most affected.

Much as many countries report a high prevalence of malaria infection, there is a variation in the way this disease impacts on pregnant women. From our results, it was evident that DRC led in the percentage of women infected with malaria during pregnancy. Wumba, Zanga, Aloni, Mbanzulu, Kahindo, & Mandina, et al. (2015) [42] associate this with the constant conflict which predisposes women to lives without proper insecticide treated nets. They suggest the use o preventive measures by use of sulphadoxine-pyrimethamine since most of them ignore other preventative methods.

The situation is improving in Malawi because the 1.5% cases of malaria in pregnancy is said to make the country better than other counterparts like Kenya, Malawi, Sudan, Mali, and Gabon (Kamuliwo, Chanda, Elbadry Lubinda Weppelmann, ... & Haque, 2015) [18]. However,

the northern parts of Zambia record lower cases than the rest of the country. Some of the reasons suggested for rather lower cases of malaria in Malawi than in most African countries good transport and communication networks which clearly elaborates malaria prone areas in the maps. With malaria in pregnancy risk maps updated properly, appropriate care and response is easy to take, thereby minimizing deaths and future cases. Otherwise, the ease of access to railways networks and proximity to large water bodies critically contribute to malaria control within the country. It is imperative to understand that many other studies of malaria have been frequented in the country, meaning evidence-based practice is common. Kamuliwo et al (2015) [18] acknowledge that the least affected districts have had numerous instances of studies which give viable reports about how to control the disease. For this reason, the government gets enough support for control of malaria through such programs that distribute nets to pregnant women. with the nets and proper education, malaria infection significantly drops. Zambia still presents a good scenario for the discussion about malaria because it scores high as far as the implementation of preventive mechanisms is concerned. For instance, Kamuliwo et al. (2015) [18] insist that the uptake of IPTp increased in 2012 as compared to the prior years. This made Zambia move from recording the highest cases of malaria in Africa in 2007 to the position it occupies today.

From the foregoing, it is evident that malaria is more common in sub-Saharan Africa, especially Central Africa and West Africa as compared to Northern Africa. Algeria is reported to have kicked entirely out malaria out of the country. According to who.int (2019), [3] the result is achieved from years of commitment to kicking the disease, the fight that spans for over a hundred years ago. Specifically, the government of Algeria has been committed to surveillance and early elimination of the disease. The government also provided free testing and treatment, leading to people being positive with healthy practices. Again, it is documented that Alegria has highly trained healthcare workers making the country ever ready to handle the situation involving any disease, not only malaria. This, together with the universal healthcare programs, have helped the country win the fight against the disease. With comprehensive and universal care, rapid response and treatment are easily achievable. These efforts by Algeria are lacking in malaria-burdened countries like Nigeria, where not much attention is paid to universal care, early diagnosis and treatment.

Other than, Algeria, Egypt is also another country that has worked hard to eliminate malaria outside its borders. According to CDC (2014) [7], Egypt has never reported any locally transmitted case of malaria. The few cases being witnessed are as a result of cross boarder transmission. The reason Egypt has succeeded in this fight is similar to the case of Algeria that is, Aswan Governorate focuses on control activities of mosquitoes causing the bacteria—their investment in surveillance and treatment as well as environmental management. Hence, control, early identification, and treatment are the surest ways of controlling malaria infection in malaria prone areas.

These countries show a common trend of lack of preventive measures like the adaptation of artemisinin-based combination therapies (ACTs), long-lasting insecticide-treated nets (LLIN), insecticide residual spraying (IRS), and early testing at the community levels. Countries which put these measures in place, for example, Algeria and Egypt and way far in fighting malaria outside their boarders.

1. The research established that the current and most effective management of malaria is the administration of sulfadoxine-pyrimethamine, a drug which is safe both for intermittent preventive treatment (IPTp) and treatment after infection. Currently, WHO has no problem with the use of such drugs as mefloquine. Quinine and quinine compounds together with chloroquine are not a preferred method of treatment due to their long elimination half-lives. Other than sulfadoxine-pyrimethamine and mefloquine women can be safe from malaria through treatment, and use of insecticide-treated nets (ITNs)

Similarly, this study concludes that three or more doses of IPTp-SP administered to pregnant women in sub-Saharan Africa result in decreased risks of adverse outcomes of malaria during pregnancy, such as LBW, as it increases birth weight than when a standard 2-dose regimen is used. The findings of this study support the WHO recommendation, which states that at least a 3-dose regimen of IPTp-SP is to be administered to pregnant women to prevent them from malarial effects (WHO, 2022) [39]. Similarly, SP may no longer be effective in protecting pregnant women against the risks of adverse outcomes of malaria during pregnancy, especially in those areas characterized by high-level resistance to anti-malarial drugs in Africa. Women who did not use mosquito prevention methods such as bed nets had a higher risk of submicroscopic placental malaria. Based on these results, one should continue to advise pregnant women in East Africa (and

probably also in other areas with endemic malaria) should use bed nets or other mosquito prevention methods to decrease the risk of submicroscopic malaria.

Further, control and management of malaria is an important strategy in endemic countries, especially on the timely diagnosis and effective treatment of malaria cases. Therefore, it is important to understand the state of the drugs against malaria and their effectiveness. Findings from the systematic review indicate that ACT is the most effective compared to non-artemisinin based anti-malarials as first-line treatment to falciparum malaria that is less complex. However, it is evident that the efficacy level of drugs against malaria in clinical settings may not reflect the actual efficacy. It is also important to mention that the findings of this study suggest that strategies and approaches against malaria adopted by different countries in Africa are working. For instance, the multi-options use of first-line treatment combined with artemisinin as well as other drugs that treat malaria are largely effective in Africa.

3.1 *Treatment of malaria*

Twelve original articles on pregnant women in Africa were included in the study for systematic review. It is important to note that some articles investigated the effect of IPTp-SP on the treatment of malaria among pregnant women (Baun et al., 2015; Mbonye et al., 2018; Mikomangwa et al., 2019; van Eijk et al., 2014) [23, 25]. Other articles investigated the adverse outcomes of malaria during pregnancy, as demonstrated in the literature review (Kalinjuma et al., 2020; Mohammed et al., 2013) [17,26]. Similarly, other articles investigated *P. falciparum* infections and measures of placental malaria (Kapisi et al., 2017). Also, Dong et al. (2020) [10] investigated the response that CXCL9 has on malaria during pregnancy. Besides, other studies found that the use of IPTp-SP among pregnant women significantly reduced the prevalence of LBW (Mbonye et al., 2018; Mikomangwa et al., 2019; van Eijk et al., 2014) [23, 25].

Another study investigated placental CXCL9 and found a close relationship – significant association – between LBW and placental malaria (Dong et al., 2020) [10]. On the contrary, a Central Sudan case-control study established that the prevalence of microscopic malaria in women with LBW deliveries was significantly higher than that of women with no LBW deliveries (Mohammed et al., 2013) [26]. Simply put, submicroscopic *P. falciparum* infection is associated with LBW and not placental malaria (Kapisi et al., 2017; Kalinjuma et al., 2020; Mohammed et al., 2013) [17, 26]. However, this study can draw such a conclusion because there is no adequate evidence to prove this statement.

3.2 Efficacy of IPTp-SP on malaria

Other studies reviewed investigated the effect of IPTp-SP on malaria among pregnant women in Africa. This investigation was done on one, two, and three doses (Baun et al., 2015; bonye et al., 2018; Mikomangwa et al., 2019; van Eijk et al., 2014) [25]. Some studies investigated the difference in the effectiveness of IPTp-SP when administered in two or three doses and its association with adverse malaria outcomes during pregnancy, such as LBW. These studies were inspired by the need to understand the efficacy of IPTp-SP in different doses and if it can protect pregnant women during the last 4 to 10 weeks of pregnancy among women in Sub-Saharan Africa. It was established that three or more doses of IPTp-SP result in decreased risk of LBW and higher birth weight than when administered in the two-dose regimen. These findings support the WHO's recommendations to offer at least three doses of IPTp-SP to pregnant women as a means of treating malaria and also combating the adverse effects of malaria during pregnancy. The recommendations are also supported by the study by Mikomangwa et al. (2019) [25], which found that when IPTp-SP is provided in a more than three dose regime results in decreased risks of LBW by 83% than when not used at all. The efficacy of IPTp-SP is demonstrated in *Fig. 5* below.

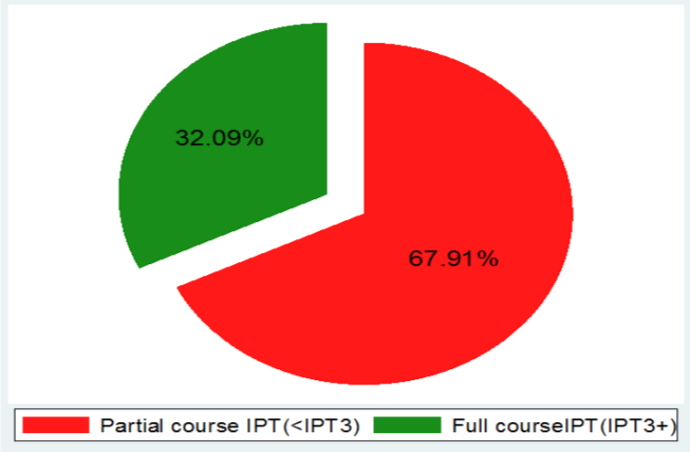

Fig 5: Efficacy of Intermittent Preventive Treatment of Malaria in Pregnancy on Pregnancy Outcome

Source: Yoah et al. (2018) [44]

The findings of by Mikomangwa et al. (2019) [25] also note that there were studies under systematic review which were products of RCT and quasi-randomized trials. My research investigated the effectiveness of anti-malarial drugs in preventing malaria and other adverse outcomes of malaria during pregnancy. Our review established that all anti-malarial drugs, when combined, are linked to decreased adverse outcomes of malaria during pregnancy, especially in

areas with a high drug-resistance level in Africa. A recent study sought the effect of *P. falciparum* SP resistance and its effectiveness in treating malaria in Africa (van Eijk et al., 2014) [36]. The findings of this meta-analysis study established that the use of IPTp-SP increases the resistance of the molecular makers of SP prevalence and thus decreases the efficacy of SP in preventing malaria infection and, consequently, the adverse outcomes of malaria during pregnancy. Therefore, based on these data, it is important to monitor the resistance to anti-malarial drugs as a policy tool that can guide healthcare scholars, practitioners, and other stakeholders on the use of anti-malarial drugs.

In malaria-endemic areas in Africa, pregnant women bear the heaviest burden of malaria infection. They also risk developing severe forms of malaria that lead to mortality. Therefore, advancing and increasing the use of anti-malarial interventions targeting pregnant women in Africa can help address the economic, cultural, and social factors that exacerbate their vulnerability. This approach will also potentially control malaria in most underserved and susceptible groups, such as pregnant women (Tegegne et al., 2019) [32].

IPTp-SP are preferred for their levels of toleration by the patients, especially pregnant women. the side effects are often mild, showing in the forms of dizziness, weakness, vomiting or nausea. These are most common in the first dose, but they significantly reduce after the second and other consecutive doses. However, WHO document on intermittent preventive treatment of malaria in pregnancy using sulfadoxine-pyrimethamine (IPTp-SP) recommends that the use of IPTp-SP as a monotherapy for malaria should be discouraged, especially among pregnant women (World Health Organization, 2014). Much more, it should be noted that IPTp-SP work more effectively in the presence of folic acid. However, the high cost of this acid may mean that the patients undergo IPTp-SP therapy without the supplement, thereby increasing their chances of developing severe side effects. Otherwise, the administration of IPTp-SP therapy should not be concurrent with that of co-trimoxazole prophylaxis because their mechanisms of actions are

redundant.

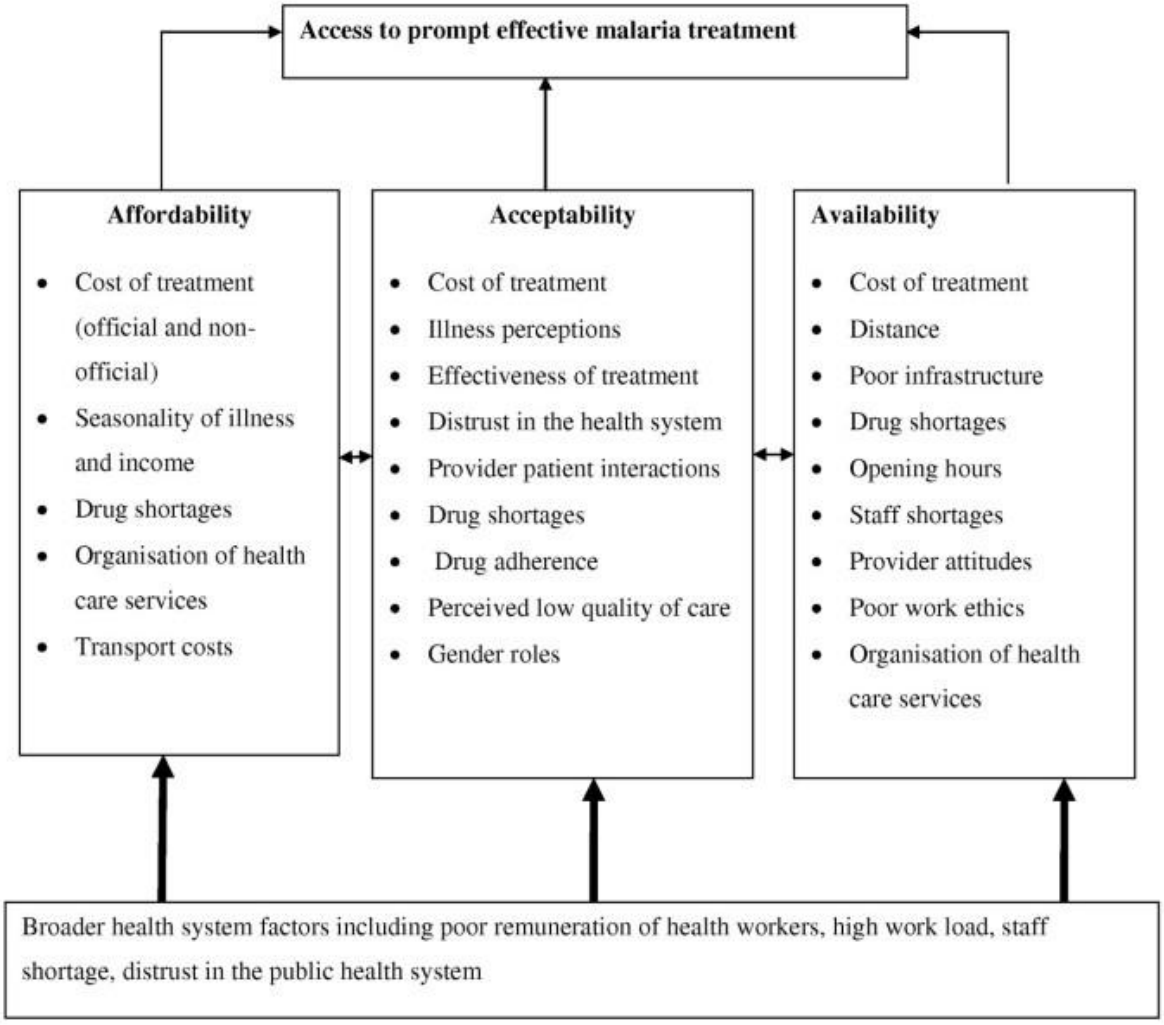

Fig 4: Health system factors that influence malaria treatment in Africa

Source Galactionova et al. (2015)

The study's findings also reveal that in regions with ineffective monitoring of drugs, unregulated use and irrational provision of anti-malarial drugs may be high. There may also be increased use of non-recommended, sub-standard, or falsified medicines with sub-optimal dosages. All these will result in the low effectiveness of anti-malarial drugs. It was also revealed that the skills and compliance of health workers when it comes to the malaria treatment guidelines, as well as the availability of drugs, influence the type of drugs to be provided to patients and whether there is proper management of treatments. All these aspects are linked to an effective drug response (Galactionova et al., 2015) [14].

It was also established that socio-demographic factors such as accessibility to towns and education of the population influence access to healthcare systems. Knowledge of the healthcare provider about the disease and that of the patient is significant in influencing the effectiveness of anti-malarial drugs. It is also important to note that Africa as a continent is characterized by economic and political upheavals which negatively influence the fight against malaria. For instance, the Central Republic of Africa and the Democratic Republic of Congo have experienced violent conflicts since the mid-1990s. Zhongming et al. (2011) [45] observe that these conflicts have resulted in the displacement of populations and the destruction of infrastructure such as healthcare facilities. Dilapidated health care systems in low-resource regions in Africa may explain why there are low estimates of anti-malarial drugs despite the adoption of ACT as a drug for first-line treatment in these regions. Additionally, malaria prevention and control measures are difficult to establish as well as implement effectively in most parts of Africa, especially in migrant populations that are highly mobile.

This study aimed to evaluate the impact of malaria and its complication for both maternal and foetus in Africa. Three main objectives, namely guided it; to investigate the frequency/incidents of malaria in pregnant women in Africa; to find out the clinical consequences of malaria in pregnant women in Africa. And evaluate the efficiency of the current treatment of malaria. To achieve these objectives, this study summarized and reviewed data collected from various studies conducted more than fifteen years ago on the impact of malaria and its complications for both maternal and foetuses in Africa. Therefore, the findings of this study may be significant in providing information to stakeholders in public health management and policymakers to devise mechanisms and strategies for eradicating malaria in all its forms and shapes. However, this study is limited by the small sample of studies selected for review.

4 Discussion

This study was carried out to understand the prevalence of malaria among pregnant women in Africa, the study focused on studying the 6 countries which WHO documents as the most malaria endemic in Africa. These countries include, Nigeria, the Democratic Republic of the Congo, Uganda, Mozambique (with infection rate of 4.2%), Angola, Burkina Faso and Ethiopia. We find out that malaria infection among pregnant women in Africa still stands at a percentage higher than 20% [46].

In another study carried in africa states that There are apparently 250 million cases and 410,000 fatalities around the world, thus more work needs to be done to completely eradicate the disease. In our study we find out that Nigeria is mentioned as recording the highest cases of malaria among pregnant women in Africa, followed by DRC. Expecting women are particularly prone to contracting malaria and its potentially fatal side effects. In other studies states that malaria can increase the risk of maternal anemia, stillbirth, early delivery, and low birth weight in addition to causing severe congenital malaria and newborn death. Identifying, preventing and treating malaria in pregnant women requires the proper precautions. This calls for a multimodal strategy that includes the use of bed nets treated with insecticides, prenatal care, and quick access to efficient treatments. There is some optimism for lowering the impact of malaria on mother and child health in Africa through coordinated efforts (Mugoya, 2023) [47].

Malaria is a devastating disease that is responsible for a significant burden of morbidity and mortality worldwide. In pregnant women, malaria can have particularly serious consequences, increasing the risk of maternal anemia, stillbirth, premature delivery, and low birth weight. Furthermore, it can lead to severe congenital malaria and neonatal death, posing a significant threat to both the mother and the newborn. The mechanisms by which malaria damages the placenta and affects fetal development are complex and multifaceted, involving a variety of immune and biochemical pathways. As such, the prevention and treatment of malaria in pregnant women represent a critical public health priority, requiring a coordinated effort from healthcare providers, governments, and communities alike (Dosoo et al., 2020) [46].

The systematic review conducted by the current study revealed that the frequency of malaria among pregnant women in Africa is still high, running at more than 20% in nearly all the sampled countries. Nigeria, Malawi, Democratic Republic of Congo lead in malaria infection

among pregnant women. Reviewed data shows that some of the most adversely affected countries like Kenya have chances of pregnant women getting infected with malaria at around 30%, Zambia around 30%, DRC around 74.1%, and Ethiopia, 12.72%. the cases are lower in North African regions of Algeria and Egypt were cases were recorded as zero.

In our study we find out that, Ethiopia presents a peculiar case being that its land is over 75% malaria prone. The peer-reviewed article by (Tegegne, Asmelash, Ambachew, Eshetie, et.al)(2009) [32] puts this country after DRC in terms of malaria, that affects pregnant women. Ethiopian women are affected by malaria differently according to their geographic locations. For instance, the highest records are in Adama, Central Ethiopia (44.6%), and the lowest in Addis Zemen Health Center (2.8%).

While in other studies finds that during pregnancy, 11.72 percent of Ethiopian women were infected with malaria (95% CI: 7.45, 17.98). According to an indicator survey conducted in 2011, malaria prevalence among the general population was 1.3%, higher than it is today. There may be a decrease in immunity and physiological changes among pregnant women that contribute to the high prevalence of malaria in this population. In contrast to a previous systematic review conducted in West and Central Africa which reported a prevalence rate of 38.2%, these results had significantly lower prevalence rates. The impact of life style and geographical location as well as the implementation of malaria control and elimination programs may have contributed to the reduction in malaria prevalence in Ethiopia, according to the current study. It has been noted that there are varying prevalence rates of malaria among pregnant women in different parts of the world, such as India (27%), Rwanda 13.6%, Uganda 87.9%, and Sudan 56.5%. This research found a substantially lower prevalence of malaria than the studies that were discussed before; the difference may be attributed to economic position, greater knowledge of pregnant women about preventive and control methods of malaria, or a combination of both of these factors (Bakken & Iversen, 2021) [48].

It has been recommended by the World Health Organization (WHO) that a number of malaria prevention and control measures should be implemented in Ethiopia to reduce the prevalence of malaria in accordance with WHO recommendations. Malaria can be stopped in a number of ways, including by using long-lasting insecticide-treated nets (LLINs), insecticide residual spraying (IRS), rapid diagnostic tests in the community, and artemisinin-based

combination therapies (ACTs). It is hoped that the prevalence of malaria in Ethiopia would reduce as a result of the implementation of these procedures, which would contribute to a general drop in the prevalence of malaria throughout the country (Gontie et al., 2020) [49].

Expecting mothers face high risk for malaria, which can have disastrous consequences on both the mother's health and her unborn child. The increased chance of low birth weight, which can cause a variety of developmental problems and consequences for the infant, is one of the malarias during pregnancy effects that is most alarming. Additionally, malaria can lead to severe anemia in a pregnant woman, which can have an effect on the health and development of the unborn child. Malaria occasionally even causes the mother or child to pass away. Sadly, access to healthcare may be constrained in some regions where malaria is common. Early diagnosis and treatment are essential to lowering the risk of severe clinical effects. More investigation is required to better comprehend the effects of malaria during pregnancy and to pinpoint efficient preventative and therapy options (Tegegne et al., 2019) [50].

In our study, Egypt is also another country that has worked hard to eliminate malaria outside its borders. Egypt has never reported any locally transmitted case of malaria. The few cases being witnessed are as a result of cross boarder transmission also same as in Algeria, These countries show a common trend of lack of preventive measures like the adaptation of artemisinin-based combination therapies (ACTs), long-lasting insecticide-treated nets (LLIN), insecticide residual spraying (IRS), and early testing at the community levels. Countries which put these measures in place, for example, Algeria and Egypt and way far in fighting malaria outside their boarders.

In other studies carried out in sub-Saharan Africa find out that, pregnancy-related malaria remains a major threat to public health, particularly in sub-Saharan Africa where the illness burden is highest. It has been documented that the current methods of treatment, which predominantly make use of ACTs (Artemisinin-based Combination Therapies), are successful in lowering maternal morbidity and death. However, the widespread use of these medications has also led to the development of drug-resistant strains of the malaria parasite, jeopardizing the long-term efficacy of these therapies. Additionally, efforts to scale up access to these therapies have been hindered by a lack of adequate healthcare infrastructure, including reliable supply

chains and skilled healthcare workers. As such, improving the efficiency of malaria treatment in pregnancy will require a multifaceted approach that includes not only strengthening healthcare systems but also investing in innovative approaches to disease prevention and management (Gontie et al., 2020).

5 Conclusion

1. The incidence of malaria in Africa Nigeria as the most malaria prone country in Africa, counting for over 31.3% of malaria deaths worldwide (Fact sheet about malaria, 2022) [12]. It is followed by Democratic Republic of Congo at 12.6%, Tanzania at 4.1 %, and Niger at 3.9%. Ethiopia, on the other hand, is of a particular concern because over 75% of its land is malaria infested
2. The clinical consequence of malaria in pregnant women and fetus, malaria can have particularly serious consequences, increasing the risk of maternal anemia, stillbirth, premature delivery, and low birth weight. The number of cases of malaria is till worrying, though a significant effort is being done by other countries like Zambia. Another revelation was that 60,000 and 360,000 infants die yearly in Africa because of LBW.
3. The efficiency and treatment of malaria must incorporate IPTp-SP. They are preferred for their levels of toleration by the patients, especially pregnant women. Specifically, sulfadoxine-pyrimethamine is the most recommended for use in the case of pregnant women.

6 Strengths and Limitations of the analysis of the study

One of the most limiting factors in this review was the access of up-to-date data of malaria infection in Africa as a continent. My research question inquired about the state of malaria infection and its impact on pregnant mothers in Africa. However, the most reliable health databases like PubMed, ResearchGate, Google Scholar, CDC, and WHO websites did not have consolidated data that painted a particular picture of Africa as far as malaria infection among pregnant mothers is concerned. Hence, the review had to consider the trends in the individual countries which have conspicuous data according to the ranking of the World Health Organization. The findings in these countries were generalized in the whole of Africa, meaning that there is a degree of external validity that might have been compromised. Moreover, since most of these studies take quite a long time to conclude, it was difficult to access very recent studies that directly answered our questions. For this reason, I had to adjust my exclusion criteria for articles within ten years to those published within the period of fifteen years. Articles published within ten years was quite scanty, and even if they were there, they were being irrelevant in many aspects. For example, some only gave a general picture of malaria, but not among pregnant women. One of the reasons cited for the

lack of sufficient data is the underreporting or poor documentation by the relevant agencies. Hence, African institutions must adopt reliable methods of documenting health records for the purposes of future policy making.

Similarly, it was impossible to quantify any heterogeneity among the selected studies regarding the confounding factors. Further, the selected studies may have had differences in the way the diagnosis of malaria was done, documented, and reported. It is also important to state that this study did not note if seasonal variations affected the transmission of malaria during pregnancy in Africa. This contributed to the difference in figures of results in which some figures were extremely low while the rest were extraordinarily high. That is the reason some measures scored over 70% while others were as low as below 16%.

The strength of this study, however, is that it guarantees a reliable degree of external validity. Much as the data reviewed were from individual countries, the sampled countries were dispersed to represent every segment of Africa in terms of Sub-Saharan, West, and North Africa. If a trend was common in all these regions, or majority of the regions, conclusions were easy to make about the whole Africa. It was found out that data from the West, East and other Sub-Saharan countries pointed towards the same direction, while those in the North also pointed the same direction. This gave room for the depiction of malaria infection in Africa from two angles. With over forty articles reviewed, there is a degree or reliability in the data presented.

Fortunately, the research was easy to carry because there was no need for survey with respondents but just a good wok in the library. All the articles reviewed were available online and the analysis was done with no technical software. The findings of this research can be generalized an important tool for further researches because it highlights an existing problem in a given demography.

1. From the literature review, it was established that Africa suffers a great loss of still births as a result of malaria infection. The World Health Organization (2018) estimates that malaria infection during pregnancy leads to over 20% of stillbirths every year. Since these still births had been associated with malaria, this research only aimed at establishing the rate at which malaria among pregnant women is dealt with. The number of cases of malaria is till worrying, though a significant effort is being done by other

countries like Zambia. Another revelation was that 60,000 and 360,000 infants die yearly in Africa because of LBW. LBW is a common factor which emanates from malaria infection during pregnancy. It might be accompanied with anaemia which results from the red blood cells trying to fight back plasmodium invasion. This inquiry established that the prevalence of malaria among pregnant women in the affected countries like Nigeria, Kenya, Angola, DRC, and Mozambique among others poses a serious threat of stillbirths as well as anaemia infection.

2. The efficiency and treatment of malaria must incorporate IPTp-SP. They are preferred for their levels of toleration by the patients, especially pregnant women. specifically, sulfadoxine-pyrimethamine is the most recommended for use in the case of pregnant women.

7 Practical Recommendations

This study recommends that there is an urgent need to;

1. Strengthen the existing control and prevention measures of malaria infection with a major emphasis on health education among members of the community.
2. Formulate and implement policies targeting interventions against malaria that involve all the stakeholders for maximum results.
3. Monitor the resistance to anti-malarial drugs and make it a policy tool that can guide healthcare scholars and practitioners as well as other stakeholders on the use of the anti-malarial drugs.

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9 Annexes

annex 1.0

LIETUVOS SVEIKATOS MOKSLŲ UNIVERSITETAS

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DĖL PRITARIMO TYRIMUI

LSMU Bioetikos centras, įvertinęs Mustaf Adan Omar pateiktus dokumentus, studento tiriamajam darbui tema „Malaria in Pregnancy“ pritaria*.

dr. Elmantas Peičius

* Pastaba: šis pritarimas neatleidžia tiriamąjį mokslinį darbą vykdančių asmenų nuo prievolės laikytis Bendrojo duomenų apsaugos reglamento nuostatų ir nuo atsakomybės gauti nacionalinio arba regioninio bioetikos komiteto leidimą, jei toks leidimas būtinas pagal LR Biomedicininių tyrimų etikos įstatyme numatytus reikalavimus.