

**SCHOOL OF PUBLIC HEALTH
COLLEGE OF HEALTH SCIENCES
UNIVERSITY OF GHANA**



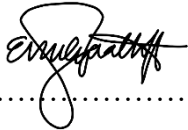
**UPTAKE OF INTERMITTENT PREVENTIVE TREATMENT OF
MALARIA WITH SULFADOXINE-PYRIMETHAMINE AND
PREGNANCY OUTCOMES IN THE GREATER ACCRA REGIONAL
HOSPITAL IN ACCRA, GHANA**

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

DECLARATION

I, Emily Saathoff, hereby declare that this dissertation is the outcome of my own original research and that references to other people's work have been duly acknowledged. I further declare that this research has not been submitted for the award of any degree at any university.



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27 April 2023

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Date



DEDICATION

This work is dedicated to Rotary International for giving me the opportunity to continue my studies, and to my parents for always supporting me in my dreams – even when those dreams take me halfway across the world.



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I sincerely thank Professor Juliana Yartey Enos, my academic supervisor, for the expertise and guidance that she so generously shared with me as I worked towards the completion of this dissertation. My gratitude also goes to my fellow classmate Ilham Shahadu for selflessly taking the time to help me with the data collection process and Yakubu Alhassan of the Biostatistics Department for his contribution to the data analysis.



TABLE OF CONTENTS

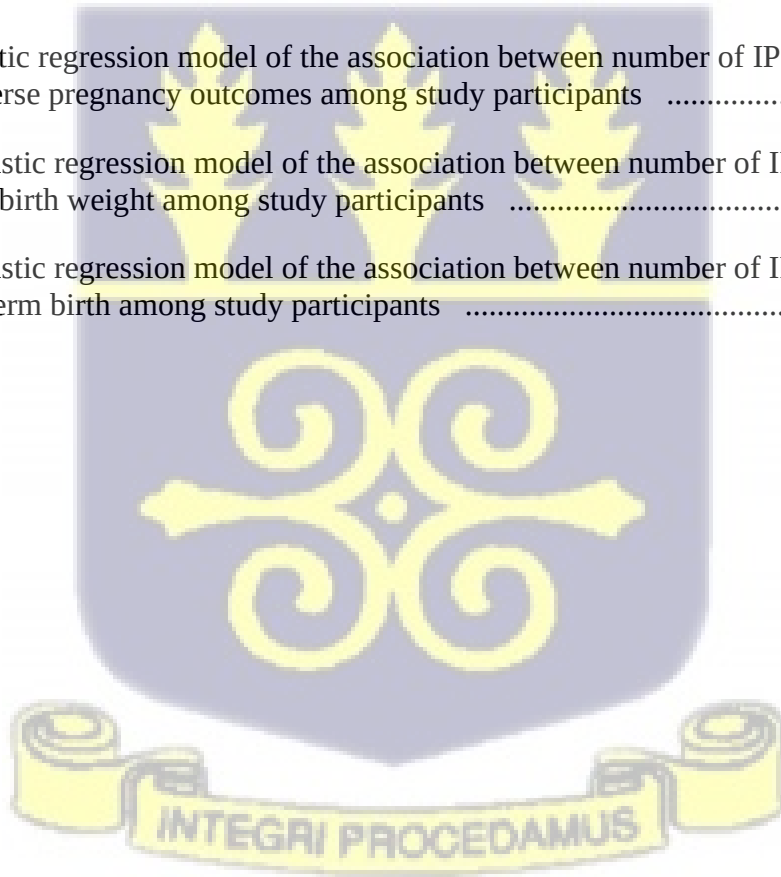
DECLARATION	i
DEDICATION	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS	iv
LIST OF TABLES	vi
LIST OF FIGURES	vii
LIST OF ABBREVIATIONS	viii
ABSTRACT	ix
 CHAPTER 1: INTRODUCTION	 1
1.1 Background	1
1.2 Problem Statement	3
1.3 Justification	4
1.4 Conceptual Framework	6
1.4.1 Narrative	6
1.5 Research Questions	8
1.6 Objectives	8
1.6.1 General Objectives	8
1.6.2 Specific Objectives	8
 CHAPTER 2: LITERATURE REVIEW	 10
2.1 Global Burden of Malaria	10
2.2 Malaria Control Initiatives	10
2.3 Malaria in Ghana	12
2.4 Overview of Malaria in Pregnancy	13
2.5 Malaria Prevention during Pregnancy	14
2.6 Antenatal Care Utilization	15
2.7 IPTp-SP Uptake	16
2.8 Factors Affecting IPTp-SP Uptake	17
2.9 COVID-19 and Malaria	18
 CHAPTER 3: METHODS	 19
3.1 Study Design	19
3.2 Study Area	19
3.3 Study Population	20
3.4 Study Variables	20
3.4.1 Independent Variables	20
3.4.2 Dependent Variables	21
3.5 Sample Size	21
3.6 Sampling	22
3.7 Research Assistants	22
3.8 Data Collection	23
3.9 Quality Control	24
3.10 Data Analysis	24
3.11 Ethical Consideration	25
3.11.1 Ethical Approval	25
3.11.2 Protocol	25

TABLE OF CONTENTS

3.11.3 Potential Risks	26
3.11.4 Study Benefits	26
3.11.5 Confidentiality	26
3.11.6 Compensation	26
3.11.7 Voluntary Participation and Withdrawal	26
3.11.8 Outcome and Feedback	27
3.11.9 Data Access and Storage	27
3.11.10 Provision of Information and Consent for Participants	27
CHAPTER 4: RESULTS	28
4.1 Sociodemographic Characteristics of Study Participants	28
4.2 IPTp-SP Uptake among Study Participants	29
4.3 Factors Associated with Overall Uptake of IPTp-SP	30
4.4 Factors Associated with Uptake of at Least Three Doses of IPT	37
4.5 Factors Associated with Uptake of at Least Five Doses of IPT	40
4.6 IPTp-SP Uptake and Pregnancy Outcomes	43
4.6.1 Proportion of Pregnancy Outcomes Among Study Participants	43
4.6.2 Association between IPTp Uptake and Adverse Pregnancy Outcomes	46
4.6.3 Association between IPTp Uptake and Low Birthweight	46
4.6.4 Association between IPTp Uptake and Preterm Delivery	47
4.7 Health Worker and Administrative Questionnaires	48
CHAPTER 5: DISCUSSION	49
5.1 Proportion of Women that Received at Least Three Doses of SP	49
5.2 Proportion of Women that Received Five or More Doses of SP	49
5.3 Proportion of Women that Received Less than Three Doses of SP	50
5.4 Association between Number of Doses of SP and Specific Pregnancy Outcomes	50
5.5 Proportion of Preterm Delivery, Low birthweight, and Stillbirth	51
5.6 Factors Associated with Uptake of IPTp-SP	51
5.7 Limitations	55
CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS	57
6.1 Conclusions	57
6.2 Recommendations	57
REFERENCES	59
APPENDICES	66
I. Participant Information Sheet	66
II. Consent Form	69
III. Patient Questionnaire	71
IV. Administrative Questionnaire	76
V. Health Worker Questionnaire	77

LIST OF TABLES

Table 1: Sociodemographic characteristics of study participants	28
Table 2: Uptake of IPTp-SP among women	29
Table 3: Bivariate association between socio-demographic characteristics and the number of IPTp doses	31
Table 4: Bivariate association between knowledge and practices number of IPTp doses	33
Table 5: Bivariate association between health system factors and the number of IPTp doses	35
Table 6: Factors associated with uptake of minimal dose of IPTp during pregnancy ...	38
Table 7: Factors associated with uptake of optimal dose of IPTp during pregnancy	41
Table 8: Association between birth outcomes and number of IPTp taken during pregnancy	45
Table 9: Logistic regression model of the association between number of IPTp doses taken and adverse pregnancy outcomes among study participants	46
Table 10: Logistic regression model of the association between number of IPTp doses taken and low birth weight among study participants	47
Table 11: Logistic regression model of the association between number of IPTp doses taken and preterm birth among study participants	48



LIST OF FIGURES

Figure 1: Conceptual framework of factors that influence uptake of IPTp-SP and pregnancy outcomes	6
Figure 2: Pregnancy outcomes among study participants	43



ABBREVIATIONS

ANC	Antenatal care
CDC	Centers for Disease Control and Prevention
CWC	Child welfare clinic
DDT	Dichloro-diphenyl-trichloroethane
DHS	Demographic and Health Survey
DOT	Directly observed therapy
FMHCP	Free maternal health care policy
GSS	Ghana Statistical Service
GTS	Global Technical Strategy for Malaria
ITN	Insecticide treated net
IPT	Intermittent preventive treatment*
IPTi	Intermittent preventive treatment of malaria in infants
IPTp	Intermittent preventive treatment of malaria in pregnancy*
IPTp-SP	Intermittent preventive treatment of malaria in pregnancy with sulfadoxine-pyrimethamine*
IRS	Indoor residual spraying
MIS	Malaria Indicator Survey
MOH	Ghana Ministry of Health
NHIS	Ghana National Health Insurance Scheme
NMCP	National Malaria Control Program
NMSP	National Malaria Strategic Plan
PMI	President's Malaria Initiative
PMC	Perennial malaria chemoprevention
SMC	Seasonal malaria chemoprevention
SP	Sulfadoxine-pyrimethamine
WHO	World Health Organization

** IPT, IPTp, and IPTp-SP all refer to the intermittent preventive treatment of malaria in pregnancy and are used interchangeably throughout this dissertation*

ABSTRACT

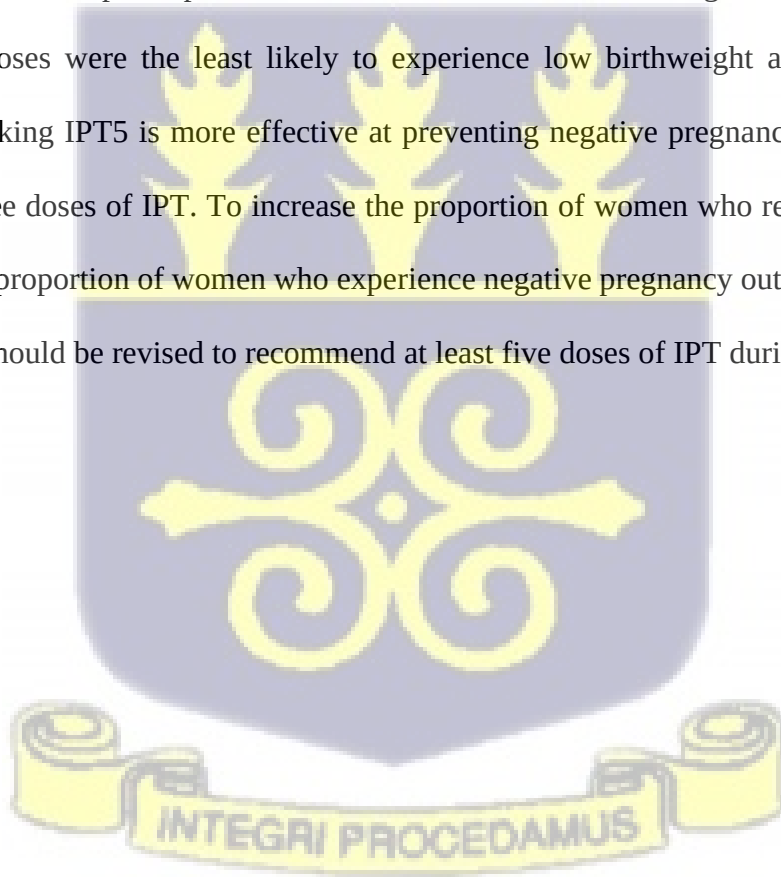
Introduction: Malaria serves as a major public health threat all around the world, with pregnant women in sub-Saharan Africa among those who are most at risk. Malaria in pregnancy is known to lead to adverse pregnancy outcomes, including preterm delivery, low birthweight, and stillbirth. To prevent malaria during pregnancy, the World Health Organization recommends that pregnant women in malaria-endemic areas receive at least three doses of sulfadoxine-pyrimethamine for the intermittent preventive treatment of malaria in pregnancy (IPTp-SP). However, current data shows that many pregnant women in Ghana do not receive three or more doses of IPT. This study seeks to determine the proportion of IPTp-SP uptake among women at the Greater Accra Regional Hospital and to explore the association between IPTp uptake and specific pregnancy outcomes, while also identifying factors associated with IPTp uptake.

Methods: A quantitative cross-sectional study design was implemented among 385 women aged 18-49 years at the Greater Accra Regional Hospital who gave birth in the six months preceding the study. Structured questionnaires were used to determine the proportions of IPTp-SP uptake and pregnancy outcomes, and to assess sociodemographic, knowledge, and health system factors. Bivariate analysis in Stata V16 was used to determine which factors were significantly associated with IPTp uptake and Pearson chi-square test was used to assess the association between pregnancy outcomes and IPTp-SP uptake. Logistic regression modelling was used to assess the effect of specific IPTp doses on low birthweight and preterm delivery.

Results: The proportion of IPTp-SP uptake was as follows: 4.4% of the women did not take any doses of IPT, 4.2% received only 1 dose of IPT, 6.5% received exactly 2 doses of IPT, 33.5% received exactly 3 doses of IPT, 23.6% received exactly 4 doses of IPT, 27.0% received exactly five doses of IPT, and 0.8% received more than five doses of IPT. Of the 385 women who participated, 15.1% received inadequate IPT (<3 doses), 84.9% received at least three

doses of IPT (IPT3+), and 27.8% achieved at least five doses of IPT (IPT5+). Low birthweight was 97% less likely among women who took at least five doses (AOR=0.03, CI=0.01-0.12, $p<0.001$) and 94% less likely among women with who took only 3-4 doses (AOR=0.06, CI=0.02-0.17, $p<0.001$) compared to women who received less than three doses. Similarly, preterm birth was 96% less likely among women who took five or more doses (AOR=0.04, CI=0.01-0.17, $p<0.001$) and 85% less likely among women with who only took 3-4 doses. (AOR=0.15, CI=0.05-0.40, $p<0.001$). ANC attendance and knowledge of malaria and IPTp-SP were associated with increased IPTp uptake.

Conclusions: While the majority of women in this study attained three or more doses of IPTp (84.9%), only 27.8% of participants took five or more doses. The finding that women who took five or more doses were the least likely to experience low birthweight and preterm birth suggests that taking IPT5 is more effective at preventing negative pregnancy outcomes than taking only three doses of IPT. To increase the proportion of women who receive IPT5+ and to decrease the proportion of women who experience negative pregnancy outcomes, the IPTp-SP guidelines should be revised to recommend at least five doses of IPT during pregnancy.



CHAPTER 1: INTRODUCTION

1.1 Background

Malaria is a severe parasitic disease that can oftentimes have life-threatening consequences for those who become infected with it. Transmitted to humans via female *Anopheles* mosquitoes, malaria is an infectious disease that poses a great public health threat around the globe – particularly in tropical areas and sub-Saharan Africa (WHO, 2014). More than half a million deaths were caused by malaria in 2020 alone, making it the deadliest vector-borne disease in the world (WHO, 2022a). Malaria is caused by a single-celled parasite called *Plasmodium*. When a mosquito bites a person who is already infected with *Plasmodium*, the parasite is taken up by the mosquito during the feed in the form of a gametocyte. The gametocytes grow and multiply within the gut of the mosquito for 10-18 days, at which point a form of *Plasmodium* called a sporozoite migrates to the salivary glands of the mosquito (Centers for Disease Control and Prevention [CDC], 2020). The disease is subsequently spread when the newly infected mosquito proceeds to bite a noninfected human host. When this happens, the sporozoites are injected into the host's bloodstream via the mosquito's saliva. The sporozoites then quickly travel to the host's liver, where they mature into schizonts and release daughter parasites known as merozoites. Once released from the liver cells, the merozoites reenter the bloodstream and invade red blood cells. There, the merozoites undergo asexual multiplication until the red blood cells burst – at which point the merozoites are free to invade more red blood cells (CDC, 2020). Some merozoites, however, are able to escape this cycle and instead differentiate into gametocytes – which ultimately allows the *Plasmodium* life cycle to continue and ensures the transmission of malaria to future hosts. There are five types of *Plasmodium* that are known to cause malaria, four of which are able to infect humans: *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium malariae*, and *Plasmodium ovale*. Infection via *Plasmodium falciparum* or *Plasmodium vivax* is associated with a greater risk of

death due to the disease, with plasmodium falciparum being the most prevalent cause of malaria in Africa (World Malaria Report [WMR], 2021).

When a person becomes infected with malaria, it typically takes a couple of weeks before the first symptoms begin to present themselves. The initial signs of a malarial infection are similar to other flu-like illnesses, including headache, fatigue, body aches, fever, and chills. More severe cases of malaria may be characterized by additional symptoms such as diarrhea, vomiting, anemia, and jaundice (CDC, 2022). All people in malaria-endemic areas are at risk of getting malaria and diagnosis with the disease should always be taken very seriously – if not treated properly, infection with malaria can quickly become fatal. In malaria endemic countries where a large portion of the population has a level of acquired immunity to the disease, children under the age of five and pregnant women have a higher likelihood of experiencing severe illness or death. However, it should also be noted that infection with malaria is usually preventable. The World Health Organization (WHO) recommends multiple preventative measures for combating malaria, including tools for reducing malaria transmission, antimalarial drugs, and a recently introduced vaccine that is being piloted in Ghana called RTS,S (WMR, 2021). Two interventions that have played a key role in reducing the spread of the disease are the use of insecticide-treated nets (ITNs) and indoor residual spraying (IRS). In addition to this, multiple forms of preventive chemotherapy have also been deployed to help minimize the severity of the disease in high-risk groups, including the intermittent preventive treatment of malaria in pregnant women and perennial malaria chemoprevention (PMC) for infants (WHO, 2022). To avert negative pregnancy outcomes, WHO specifically recommends a three-pronged approach for the prevention and control of malaria during pregnancy. The approach includes the following:

1. The intermittent preventive treatment with sulfadoxine-pyrimethamine (IPTp-SP).
2. The use of insecticide-treated nets (ITNs).

3. Effective case management of malaria.

This study specifically investigated the uptake of intermittent preventative treatment with sulfadoxine-pyrimethamine by pregnant women in Accra, Ghana and its relationship with pregnancy outcomes.

1.2 Problem Statement

According to the WHO, Ghana is classified as a moderate and high malaria transmission country (WMR, 2021). Malaria infection during pregnancy is a major health concern for mothers and newborns in malaria endemic countries, including Ghana (Ghana Statistical Service [GSS], 2019). As one of the leading causes of morbidity and mortality in pregnant women, there is a large concern regarding the ongoing negative effects of malaria on pregnancy outcomes (WHO, 2014). For pregnant women residing in Ghana, 16.8% of hospital admissions and 3.4% of deaths are caused by malaria (Owusu-Boeteng & Anto, 2017). Adherence to WHO's recommendations for the control of malaria during pregnancy using intermittent preventative treatment in pregnancy with sulfadoxine-pyrimethamine (IPTp-SP) can play a major role in reducing the incidence of adverse pregnancy outcomes as a result of malaria and malaria-related illnesses. WHO guidelines for Ghana suggest that pregnant women should aim to receive a minimum of three or more doses (IPT3+) throughout the course of their pregnancy, though five doses (IPT5) is the ideal target. The first dose should be administered around the sixteenth week of pregnancy (not before the second trimester) or at the first sign of quickening, and subsequent doses should be spaced at least one month apart in order to achieve optimal results, i.e. positive pregnancy outcomes (Kayentao et al., 2013). Implementation of this intervention, however, has been proven to have many challenges. According to the Ghana Statistical Service's (GSS) 2019 Malaria Indicator Survey (MIS), many women in Ghana fail to receive three or more doses throughout the course of their pregnancies, with many women

participating only partially and some women not participating in the intervention at all despite widespread availability.

Adherence to WHO's protocol for IPTp-SP implementation is essential for reducing the risk of adverse pregnancy outcomes as a result of malaria in pregnancy. Possible adverse outcomes include low birthweight, preterm delivery, placental parasitemia, maternal and fetal anemia, stillbirth, and neonatal mortality (Darteh, et al., 2019). The purpose of this study is to determine the level of IPTp-SP uptake at the Greater Accra Regional Hospital and to identify the factors associated with its uptake. The study will also explore the relationship between IPT uptake and birth outcomes – specifically preterm delivery, low birthweight, and stillbirth – and to identify factors that may influence IPTp-SP uptake among pregnant women in Ghana.

1.3 Justification

According to the WHO 2021 World Malaria Report, global malaria deaths increased by 12% in 2020, with the West Africa WHO subregion accounting for the highest prevalence of exposure to malaria during pregnancy, 39.8%. In addition to this, data indicates that the WHO African Region is off track by approximately 40% for reducing both malaria morbidity and mortality, and the percentage of pregnant women who received at least three doses of intermittent preventive treatment was found to be only 32% - which is well below the coverage goal of 80% (WMR, 2021). In Ghana, the National Malaria Control Program (NMCP) set a goal in 2008 of reaching 100% of pregnant women with at least two doses of IPTp-SP (IPT2) by 2015 (MOH, 2008). Data from the 2019 Ghana MIS show that this goal has yet to be achieved, and few studies have focused on the association between uptake of IPTp-SP and pregnancy outcomes (Owusu-Boeteng & Anto, 2017). In accordance with WHO guidelines for the prevention of malaria during pregnancy, the NMCP now recommends that pregnant women receive at least three doses IPTp-SP (IPT3+).

Ghana is one of 35 countries located within the WHO African Region that implements the intermittent preventive treatment of malaria in pregnancy (IPTp) nationally as a means of reducing the burden of malaria on pregnancy (WMR, 2021). This, combined with the fact that Accra is the most populated city within the country, makes the Greater Accra Regional Hospital an ideal study population. This study has the potential not only to provide insight into the relationship between pregnancy outcomes and patient adherence to IPTp-SP recommendations, but to also identify the specific determinants that may be influencing the decision or ability of women in Ghana to receive the intervention. If enabling and hindering factors are not identified, the ability of IPTp-SP to successfully avert the severe effects of malaria during pregnancy may be undermined by the high prevalence of pregnant women who are currently not benefitting from the intervention in spite of its national implementation – whether it be due to availability, accessibility, knowledge, or sociodemographic factors. An additional benefit of this study is that it will report the proportion of women who receive all five doses of IPTp-SP. The 2016 and 2019 Ghana MIS only report the proportion of women receiving the minimum recommendation of three doses, so this study has the potential to fill the gap in knowledge that exists regarding the proportion of women who actually receive all five doses of SP and their subsequent pregnancy outcomes.

With low- and middle-income countries such as Ghana shouldering a disproportionately large portion of malaria cases and deaths, and with pregnant women being one of the most vulnerable populations at risk of dying from the disease, it is important that studies such as this are conducted to provide data that is both country-specific and up-to-date. In Ghana, the data collected from this study could potentially shed light on disparities in IPTp-SP uptake, thus paving the way for public health officials to make modifications to current malaria prevention efforts. Implementation adjustments may lead to a more inclusive program and further reduction of malaria case incidence, mortality rates, and malaria-induced adverse

pregnancy outcomes. By studying the relationship between IPTp-SP uptake and pregnancy outcomes, it is hoped that Ghana and similar countries will be able to achieve malaria elimination – which will ultimately help bring the world one step closer to achieving the third sustainable development goal set forth by the United Nations: to ensure healthy lives and promote well-being for all at all ages.

1.4 Conceptual Framework

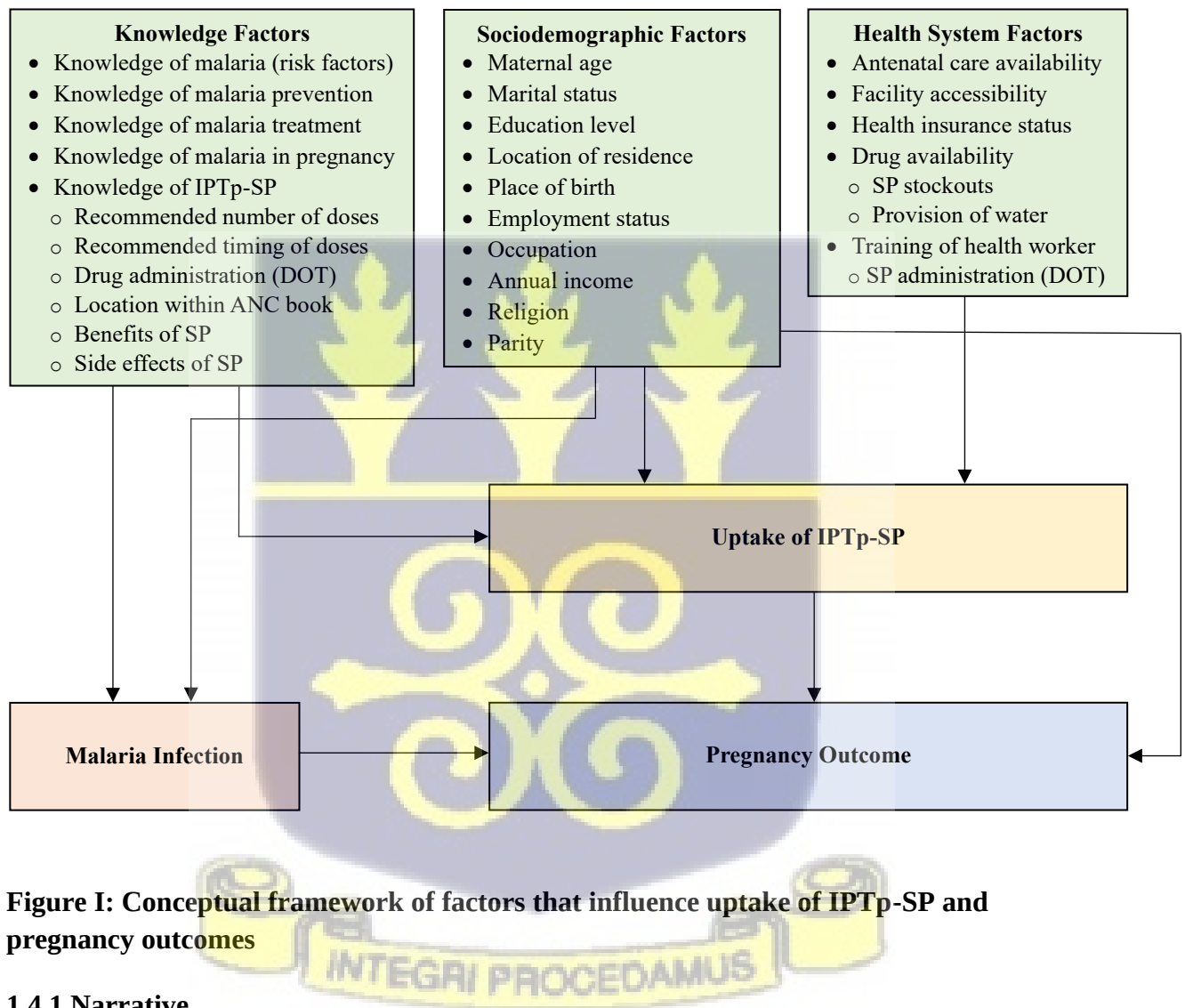


Figure I: Conceptual framework of factors that influence uptake of IPTp-SP and pregnancy outcomes

1.4.1 Narrative

Figure I, shown above, depicts a conceptual framework that aims to demonstrate the relationship between a multitude of factors and their effects on both IPTp-SP uptake and pregnancy outcomes. Factors that may affect the uptake of IPTp-SP in this study include a

combination of knowledge, sociodemographic, and health system characteristics. The sociodemographic factors that can influence the uptake of IPTp-SP by pregnant women include level of education, religious beliefs, location of residence, and socioeconomic status – the latter of which can be inferred from one's employment status, occupation, and annual income. Women with lower levels of education and those who come from low-income households may be less likely to complete the intervention due to a lack of awareness of program benefits and financial constraints. Similarly, those with religious beliefs that view medicine as nonessential or are born in communities where these beliefs are more prevalent may opt not to participate in the intervention. Women who live in residential areas that are not equipped with a health system that administers IPTp-SP will face challenges in accessing the intervention as well. It is important to note, however, that access to the health facility can only increase IPTp-SP uptake if the health facility has a reliable stock of SP and health workers who are trained in the administration of the drug. In addition to these factors, high maternal age and high parity can directly lead to an increased risk of adverse pregnancy outcomes. Women with lower levels of education will subsequently suffer from a lack of knowledge of malaria, including malaria risk factors, prevention, and treatment. This lack of knowledge can lead to a decreased likelihood of one participating in the IPTp-SP intervention and thus an increased likelihood of one experiencing a poor pregnancy outcome. Knowledge of IPTp-SP protocol and benefits, or lack thereof, can have a major impact on the decision of women to participate in the intervention as well. The availability and accessibility of IPTp-SP and antenatal care will also directly impact the uptake of IPTp-SP by pregnant women in Ghana. Women who have access to health insurance and are able to attend regular antenatal visits at a healthcare facility that offers IPTp-SP will be more likely experience optimal benefits, whereas noninsured women who do not attend regular antenatal care visits will be less likely or unable to receive IPTp-SP. Women who do not receive optimal IPTp-SP uptake may have a greater chance of experiencing adverse

pregnancy outcomes such as preterm delivery, low birthweight, and neonatal mortality. As demonstrated in the conceptual framework, malaria during pregnancy can have a direct impact on pregnancy outcomes. Thus, it is important to recognize the impact of sociodemographic, knowledge, and health system factors so that IPTp-SP uptake is optimized and adverse pregnancy outcomes are prevented.

1.5 Research Questions

1. What is the proportion of pregnant women that receive 0-5 doses of IPTp with sulfadoxine pyrimethamine (SP) during pregnancy at the Greater Accra Regional Hospital?
2. Is there a relationship between the number of doses of SP received during pregnancy and pregnancy outcomes of women at the Greater Accra Regional Hospital?
3. Is there a significant association between IPTp-SP uptake and specific pregnancy outcomes, including premature delivery, low birthweight, and stillbirth?
4. What factors are associated with the uptake of IPTp-SP uptake among pregnant women at the Greater Accra Regional Hospital?

1.6 Objectives

1.6.1 General Objectives

- To assess the uptake of IPTp-SP, its determinants, and association with pregnancy outcomes among mothers at the Greater Accra Regional Hospital in Accra, Ghana.

1.6.2 Specific Objectives

- To determine the proportion of pregnant women who receive a minimum of three doses of IPT prior to delivery.
- To determine the proportion of pregnant women who receive the optimal doses of IPT (IPT5+) prior to delivery.

- To determine the proportion of women who fail to receive the recommended minimum of three doses of IPT (<3 doses) prior to delivery.
- To determine if there is an association between the number of doses of IPT received and specific pregnancy outcomes.
- To determine the proportion of specific pregnancy outcomes among study participants, including preterm delivery, low birthweight, and stillbirth.
- To identify factors associated with the uptake of IPTp-SP among postnatal mothers at the Greater Accra Regional Hospital.



CHAPTER 2: LITERATURE REVIEW

2.1 Global Burden of Malaria

Despite a decline in global malaria incidence by 37% between 2000-2015, half of the world's population remains at risk of contracting malaria. In 2020, there were approximately 241 million cases around the globe, of which 627,000 were deaths (WMR, 2021). Around 95% of these malaria cases can be attributed to the WHO African region, which recorded approximately 228 million cases of malaria in 2020 alone (WMR, 2021). African countries continue to shoulder the greatest burden of the disease, with roughly nine out of every ten malaria cases in 2015 occurring within the WHO African Region. Sub-Saharan Africa in particular remains the source of most of the world's malaria cases, with the Democratic Republic of the Congo and Nigeria reportedly accounting for more than one third of global malaria deaths (WMR, 2021).

Pregnant women and children under five are the most vulnerable to malaria and its consequences. Among the 33 countries within the WHO African Region with moderate or high transmission of malaria in 2020, it was estimated that 34% of the 33.8 pregnancies within the region that year were exposed to infection with malaria. West Africa accounted for roughly 40% of malaria exposure during pregnancy – the highest prevalence of any WHO African subregion (WMR, 2021). It has been estimated that more than 800,000 infants were born with low birthweight as a result of malaria infection during pregnancy in 2020, with more than half of these infants being born in West Africa. If West African countries are able to optimize IPT3 coverage to 90% of the population of pregnant women, more than 100,000 low birthweights can be prevented (WMR, 2021).

2.2 Malaria Control Initiatives

Malaria is a life-threatening infectious disease that has been a major cause of mortality throughout human history and continues to pose a threat to public health around the globe to this day. Efforts to eradicate malaria date back to WHO's Global Malaria Eradication Program

(GMEP) in 1955, which aimed to disrupt malaria transmission by attacking mosquitoes with the insecticide dichloro-diphenyl-trichloroethane (DDT) and using chloroquine for malaria prevention and treatment (WHO, 2016a). Though the program led to the successful eradication of malaria in 15 countries, it failed to have a meaningful impact on sub-Saharan Africa and was later discontinued as a result. Subsequent initiatives to eradicate malaria include the 1992 WHO Global Malaria Control Strategy and the Roll Back Malaria initiative, the latter of which sought to reduce the global burden of malaria by 50% before 2010 (WHO, 2016a).

In response to the many remaining challenges to malaria eradication, the Global Technical Strategy for Malaria 2016-2030 (GTS) was introduced by WHO in 2015 to scale up malaria prevention, diagnostic testing, treatment, and surveillance. The GTS consists of milestone goals for malaria mortality and case incidence in 2020 and 2025, along with target goals to be achieved by 2030. Using 2015 data as a baseline, the strategy aims to reduce global malaria mortality rates and case incidence by at least 40% in 2020, 75% in 2025, and 90% in 2030. The GTS also seeks to achieve malaria elimination in an additional 10 countries by 2020, 20 countries by 2025, and 35 countries by 2030 – all while preventing the resurgence of malaria in countries that have already eliminated the disease (WHO, 2021). The 2021 World Malaria Report indicates that the GTS 2020 milestones for mortality and morbidity have yet to be achieved globally and will be off track by more than 90% in 2030 if the current trajectory continues (WMR, 2021).

In Ghana, the National Malaria Control Program (NMCP) of the Ghana Ministry of Health (MOH), with support from the President's Malaria Initiative (PMI), develops strategic plans to minimize the spread and impact of malaria within the country. Ghana's most recent National Malaria Strategic Plan (NMSP) spanned from 2014 to 2020 and had a primary objective of reducing malaria morbidity and mortality by 75% in all regions by 2020. Additional objectives included the protection of at least 80% of the population from malaria

with preventive interventions by 2020, with malaria prevention interventions including indoor residual spraying (IRS), universal coverage with ITNs, and IPTp (PMI, 2022). Using the 2019 data as a baseline, the current NMSP has a main goal of reducing malaria mortality and malaria case incidence by 90% and 50% respectively by 2025. The specific objectives of the 2021-2025 NMSP include the following:

- Protection of 80% of the population at risk of malaria with malaria prevention interventions by 2025
 - Protection of 80% of pregnant women with malaria prevention interventions, including IPT3+, by 2025
- Coverage of 95% of the population with at least one preventive measure against malaria by 2025
- Appropriate diagnosis of all suspected malaria cases and effective and appropriate treatment of 100% of confirmed cases by 2025
- Achievement of malaria pre-elimination status in seven districts by 2025

2.3 Malaria in Ghana

Malaria is endemic in Ghana and 100% of the more than 32 million people who live there are at risk of malaria. In 2016, Ghana recorded 1,264 in-patient malaria deaths, of which 590 were children below the age of five and 674 were among individuals five years of age and older (GHS, 2016). In 2020 alone, it is estimated that there were 7 million cases of malaria and approximately 13,000 malaria-related deaths in Ghana. Despite the high burden of malaria in Ghana, significant progress in malaria control has been made due to the NMCP. Along with Ethiopia, Mauritania, and the Gambia, Ghana was one of only four countries in sub-Saharan Africa to achieve the GTS target of reducing malaria case incidence by 40% in 2020; however, Ghana failed to reduce malaria mortality by more than 40% and thus did not meet the GTS 2020 milestone for mortality (WMR, 2021).

In sub-Saharan Africa, there is a notable association between seasonality and risk of malaria infection, with the risk of infection fluctuating between the rainy and dry seasons. In Ghana, peak rainy season occurs from April to June and September to November in the southern and central parts of the country, whereas in the Northern region it lasts from May through September (PMI, 2022). The rainy season is accompanied by elevated levels of malaria transmission. When comparing the prevalence of malaria infection during pregnancy in the rainy season versus the dry season, a study in Navrongo found that the prevalence of malaria infection for those who were pregnant within the rainy season was 1.48 times that of those who were pregnant during the dry season (Berry et al., 2018). In 2016, the use of ITNs by pregnant women in Ghana was only 37% in the Greater Accra region, the lowest of any region in Ghana with the exception of the Western region. This is not necessarily surprising considering that the 2016 MIS also reported that only 39% of pregnant women in urban areas reported sleeping under an ITN as compared to 60% in urban areas (GSS, 2016).

Pregnant women in Ghana are amongst the most vulnerable when it comes to infection with malaria, and 13.7% of pregnant women were hospitalized as a result of malaria in pregnancy in 2014 (Osarfo et al., 2022). Ghana has a maternal mortality ratio (MMR) of 319 maternal deaths per 100,000 live births and malaria in pregnancy is estimated to be the cause of death for 9% of the country's maternal deaths (Odjidja et al., 2017).

2.4 Overview of Malaria in Pregnancy

Asymptomatic malaria infection is common in high-transmission areas such as Ghana and can lead to maternal anemia and placental parasitemia (WHO, 2007). Episodes of severe malaria in pregnancy are known to result in stillbirth, spontaneous abortion, fetal growth restriction, maternal anemia, premature delivery, low birthweight, and infant and maternal mortality (WHO, 2007). Though a level of protective immunity is typically acquired by individuals living in areas of moderate to high malaria transmission, immunity among pregnant

women reduces as the pregnancy progresses, making them more prone to infection (WHO, 2022). Risk factors including parity and maternal age may determine one's likelihood of experiencing the adverse effects of malaria in pregnancy, with adolescents and paucigravidae being the most at-risk groups (Desai et al., 2007).

An analysis of more than 2,000 women in Malawi concluded that persistent malaria during pregnancy was associated with an increased risk of preterm birth (van den Broek et al., 2014). In addition to this, a meta-analysis examining the relationship between malaria endemicity and stillbirth showed that the detection of *plasmodium falciparum* at delivery was associated with an increased odds of stillbirth (Moore et al., 2017). A similar association between malaria in pregnancy and low birthweight was found by a study of 322 mothers in Nigeria, where neonates born to mothers diagnosed with placental malarial infection resulted in 45% of neonates being born with low birthweight (Aribodor, 2009).

2.5 Malaria Prevention during Pregnancy

The World Health Organization recommends a multifaceted approach for preventing malaria during pregnancy. In addition to IPTp-SP, PMC and SMC are recommended. It should be noted that PMC refers to what was previously called intermittent preventive treatment of malaria in infants (IPTi), a change introduced by WHO in the updated June 2022 guidelines for malaria (WHO, 2022).

IPTp consists of a complete therapeutic course of antimalarial medication that is delivered to pregnant women at predetermined intervals to prevent mothers and their unborn children from severe malaria. IPTp is a type of preventive chemotherapy, which is the use of antimalarial medicines to prevent infection with malaria and its consequences. In Ghana, SP, sometimes referred to as Fansidar, is the drug that is used for IPTp, and it is provided to pregnant women as a directly observed therapy (DOT) at the first antenatal care (ANC) visit after quickening or around the sixteenth week of pregnancy (GDNP, 2017). It is given to

women in the form of three tablets that are taken orally and have a combined total dosage of 1500mg/75mg. A meta-analysis of seven trials evaluating IPTp-SP undertaken by WHO revealed that three or more doses of IPTp-SP was associated with higher mean birthweight than two or less doses of IPTp-SP (WHO, 2022b). It was also found that three or more doses of IPTp-SP was associated with fewer low birthweight births than two or less doses of IPTp-SP (WHO, 2022b). For these reasons, WHO recommends that pregnant women in malaria endemic countries receive three or more doses of IPTp-SP beginning as early as possible during the pregnancy but not before 13 weeks.

2.6 Antenatal Care Utilization

WHO recommends that pregnant women have eight contacts with ANC throughout their pregnancy, starting by the twelfth week of the pregnancy and continuing up until delivery (WHO, 2016b). In 2008, the National Health Insurance Scheme (NHIS) introduced the free Maternal Health Care Policy (FMHCP) in an attempt to provide all pregnant women with comprehensive maternal and newborn healthcare. This policy allows women in Ghana who are clinically confirmed as pregnant to access care without paying a premium or having to pay for services out of pocket (Dalinjong, 2018). In practice, however, many women continue to cite financial barriers as a reason for not obtaining ANC. IPTp-SP is included as part of the ANC package for pregnant women in Ghana and is administered at both public and private facilities throughout the country.

In West Africa, there is low bed net use among young women and a high prevalence of pregnant women with asymptomatic malaria infections that aren't diagnosed until their first contact with ANC. For this reason, the first ANC visit is especially important because it is during this visit that ITNs are typically distributed to pregnant women. (Berry et al., 2018). The timing of the first ANC visit is also important because in order to optimize IPTp-SP uptake to the full five doses, it is necessary for pregnant women to attend ANC appointments no later

than 16 weeks gestational age. A 2017 study by Owusu-Boateng and Anto demonstrates the importance of this timing, with their results showing that women who received their first dose of SP during the third trimester were less likely to receive IPT3+ than those who received it during the second trimester. However, it is also important to note that attending ANC appointments within the appropriate time frame will only enable women to receive more doses of IPTp-SP if the health facility has a readily available supply of SP and a staff who are trained on how to administer it. Among 350 women in the Bugiri District of Uganda, more than 50% cited SP stockouts as a reason for not receiving IPTp-SP. The provision of free clean water during the ANC visit was found to have a statistically significant association with IPTp-SP uptake as well (Muhumuza et al., 2016). An additional study in Cameroon found alarming results regarding the knowledge of health care providers about IPTp. Among 39 surveyed healthcare workers, 28.2% did not know that IPTp was supposed to be initiated at early in the second trimester and more than one third reported having never received any training on IPTp at all (Diengou et al., 2020).

2.7 IPTp-SP Uptake

Region-specific data from the 2014 Demographic and Health survey (DHS) shows that the Greater Accra region had one of the lowest percentages of women who received IPTp-SP in Ghana, with only 78.2% of pregnant women recorded to have received any IPT during an ANC visit. Only 35.3% of pregnant women in the Greater Accra region received IPT3+ as compared to more than half of women in the Brong Ahafo region (GSS et al., 2014). An increase in IPT3+ uptake in the Greater Accra region was observed in 2016, with 58% of pregnant women aged 18-49 recorded as having received at least three doses. However, this percentage was among the lowest – the only regions that recorded a lower percentage of IPT3+ uptake were the Northern and Western regions, which recorded 50% and 48% respectively (GSS, 2016). A review of the literature revealed that national data on the uptake of IPT5 in

Ghana is scarce. However, an annual report from the Ghana Health Service shows that 63,810 pregnant women received IPT5 in 2016, which makes up only 6.7 percent of the 954,937 women who were pregnant that year (GHS, 2016). This means that more than 90% of pregnant women in Ghana failed to obtain optimal IPT doses and indicates that there is much room for improvement.

In order for IPTp to be effective, it is crucial that pregnant women receive at least three doses of IPT during pregnancy. A systematic review of seven studies in sub-Saharan Africa comparing two versus three doses of SP and the risk of low birthweight revealed that IPT3+ was associated with a higher mean birthweight and a decreased risk of low birthweight compared with IPT2 (Kayentou et al., 2013). An additional study looked at the IPT3+ uptake and pregnancy outcomes of 631 pregnant women in Tanzania and found that those who contracted malaria during pregnancy had 11 times greater risk of low birthweight (Mikomangwa et al., 2019). Provided that preterm delivery and low birthweight are strong risk factors for neonatal mortality, it can be hypothesized that optimal utilization of IPTp-SP can minimize the adverse effects of malaria in pregnancy and potentially save many lives.

2.8 Factors Affecting IPTp-SP Uptake

Data from analysis of the 2016 MIS indicates that the proportion of Ghanaian women who received three or more doses of IPTp-SP during pregnancy was 63%, the proportion of Ghanaian women who received one to two doses of IPTp-SP during pregnancy was 27%, and the proportion of Ghanaian women who received no doses of IPTp-SP during pregnancy was 10% (Darteh et al., 2019). This data is based off a total of 1,220 women in Ghana between the ages of 18 and 49 who attended ANC visits throughout the course of their pregnancies. Data from this analysis also showed a statistically significant association between the uptake of IPTp-SP and women's education level, religion, health insurance coverage, age, region of residence, and knowledge of malaria. These findings are supported by similar data collected

from the 2019 MIS, which shows that only 61% of women received IPT3+ in 2019 – a finding that is not significantly different from the 63% recorded in 2019. Failing to attend ANC visits early enough during the pregnancy has been suggested as a reason for the low number of women receiving IPT3+, for those who start the intervention later on in the pregnancy may not have enough time to receive three doses before delivery (GSS, 2019). In addition to this, geographic variations in IPTp-SP uptake were reflected in the data from the 2014 DHS. The percentage of pregnant women ages 18-49 who received any IPTp-SP was highest in the Brong Ahafo region and lowest in the Northern region (GSS et al., 2014).

2.9 COVID-19 and Malaria

In 2020, the global case incidence of malaria rose to 59, a stark contrast to the previous reduction from 81 to 56 that occurred between 2000 and 2019. Despite a decrease in malaria deaths per 100,000 population from 14.8 to 13.8 between 2015 and 2019, malaria deaths dramatically increased to 15.3 deaths in 2020 (WMR, 2021). Global malaria deaths increased by 69,000 deaths between 2019 and 2020 – an increase of approximately 12%. More than two thirds of these additional deaths are estimated to be due to COVID-19 service delivery disruptions (WMR, 2021).

Within the WHO African region, it is estimated that a substantial increase in malaria cases and deaths occurred between 2019 and 2020, with 213,000 cases and 534,000 deaths reported in 2019 and 228,000 cases and 602,000 deaths reported in 2020 (WMR, 2021). The increase in malaria cases around the world can likely be partially attributed to the ongoing COVID-19 pandemic, which led to unprecedented healthcare service and delivery disruptions (WMR, 2021). It is possible the outcomes of this research may differ from similar studies conducted before the pandemic as a result of the effect of these disruptions on IPTp-SP uptake.

CHAPTER 3: METHODS

3.1 Study Design

A quantitative cross-sectional study design was used for the implementation of this study. Data was collected by the PI and research assistants from the ANC books of women who gave birth at the Greater Accra Regional Hospital in the 6 months preceding the study – which was carried out in January and February 2023. Information regarding IPTp-SP uptake and birth outcomes was collected from the ANC books of women who consented to participate in the study. Additional supporting information was collected from postnatal mothers and health workers using semi-structured questionnaires in the postnatal unit, postnatal annex, and child welfare clinic (CWC) at the Greater Accra Regional Hospital. Data from these questionnaires yielded information on potential explanatory variables associated with IPTp-SP uptake and/or pregnancy outcomes. These variables included the sociodemographic characteristics of participating pregnant women as well as their knowledge of malaria, malaria prevention and treatment, and IPTp-SP. Additional explanatory variables included the availability of SP in the facility, such as the incidence of any stockouts within the last six months, and whether or not health workers received any training specific to IPTp-SP.

3.2 Study Area

The study was carried out at the Greater Accra Regional Hospital, also referred to as Ridge Hospital, in Accra, Ghana. It is located at North Ridge and within the Osu-Klottey Sub-Metro of the Greater Accra Metropolitan area. Its classification as a Regional Hospital means that it serves the entire population of the Greater Accra Region, which has an estimated population of 5,455,692 as of 2021. The immediate population served by the hospital, however, is made up of the Accra New Town, Achimota, Adabraka, Airport Residential Area, Central Accra, Kanda, Kotobabi, La, Maamobi, Nima, Osu, and Ridge suburbs.

3.3 Study Population

The study population was made up of postnatal women aged 18-49 years old who had given birth in the six months preceding the study at the Greater Accra Regional Hospital and consented to participate in the study. Specific exclusion criteria were enforced to limit recall bias in questionnaire responses and to reduce the impact of confounding factors, i.e. pre-existing medical conditions, on the outcome variable, pregnancy outcomes. Women with the pre-existing medical conditions shown below were excluded from the study as a means of reducing this impact and because these conditions could be verified by the data recorded in their ANC books. Women below the age of 18 were not recruited for the study due to the increased likelihood of adverse pregnancy outcomes that is associated with adolescent pregnancies (Althabe et al., 2015).

Exclusion criteria:

- Women who are ill
- Women whose children are ill
- Women with the following pre-existing medical conditions: sickle cell disease, diabetes, heart disease, HIV infection, and epilepsy.
- Women who do not consent to participate in the study
- Women who are below 18 years old
- Women who gave birth more than 6 months before the start of the study

3.4 Study Variables

3.4.1 Independent Variable (Primary)

- Uptake of IPTp-SP during pregnancy
- Number of doses of SP received (<3 doses considered inadequate uptake, 3 doses considered adequate uptake, 3-4 doses considered sub-optimal uptake, 5+ doses considered optimal intake)

- No IPT
- One dose of SP (IPT1)
- Two doses of SP (IPT2)
- Three doses of SP (IPT3)
- Four doses of SP (IPT4)
- Five doses of SP (IPT5)
- More than five doses of SP (IPT6+)

3.4.2 Dependent Variables

- Pregnancy outcomes
 - Low birthweight
 - Premature delivery
 - Stillbirth
 - Positive pregnancy outcome

For the purposes of this study, a positive pregnancy outcome is considered a pregnancy that did not result in low birthweight, preterm delivery, or stillbirth.

Name	Definition	Type
Primary Independent Variable(s)		
Uptake of IPTp-SP	Whether mother received IPTp-SP during pregnancy	Binary
Number of doses of SP received	Receipt of no IPT, IPT1, IPT2, IPT3, IPT4, or IPT5+, as well as IPT<3 and IPT3+	Categorical
Dependent Variable(s)		
Pregnancy outcome	Premature delivery, low birthweight, stillbirth, or positive pregnancy outcome	Categorical

3.5 Sample Size

The sample size for the study was determined to be 385 by using Cochran's formula. According to the 2016 Ghana MIS, the proportion of women who received three or more doses of IPTp-SP during pregnancy was 61%. Because data from the survey neglects to reveal the

number of women who took 5 or more doses of IPTp-SP, a prevalence of 50% was assumed and used in the sample size calculation.

$$n = \frac{Z^2 pq}{e^2}$$

$$n = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2}$$

$$n = \frac{3.8416 (.25)}{.0025}$$

$$n = \frac{.9604}{.0025}$$

$$n = 384.16$$

$$n = 385$$

3.6 Sampling

A simple random sampling method was used to select participants among women aged 18-49 who gave birth at the Greater Accra Regional Hospital within six months of the study. Due to time constraints, all eligible women who consented to participation were included in the study. However, some level of randomness was achieved during the data collection process by alternating the days and times in which the questionnaires were administered in the various departments. For example, the questionnaires were conducted on Monday, Wednesday, and Friday in one department as opposed to visiting each department every day of the week.

3.7 Research Assistants

Research assistants were recruited from the Greater Accra Regional Hospital and the School of Public Health at the University of Ghana. Research assistants underwent an orientation with the PI to ensure that they were familiar with the study instruments, the inclusion and exclusion criteria for the study, ethical issues, and how to obtain consent from the study participants. Research assistants were required to be at least one of the following:

- Nurse
- Midwife

- Health worker with tertiary education

3.8 Data Collection

A research assistant was recruited from the Greater Accra Regional Hospital to assist with accessing and obtaining data on IPTp-SP uptake from women's ANC books and hospital records at the facility. The timing and number of antenatal care visits attended, and the uptake of IPTp-SP were obtained from ANC books. The specific number of doses of SP received by participating women was obtained from ANC books, with the options being the uptake of no IPT, a single dose (IPT1), two doses (IPT2), three doses (IPT3), four doses (IPT4), or five doses (IPT5) – the latter of which was considered as the optimal number of doses. At least three doses of IPTp-SP (IPT3+) is considered adequate for protection from malaria during pregnancy, but 3-4 doses was considered sub-optimal for the purposes of this study. Less than three doses of IPTp-SP was considered inadequate. Quality assurance was obtained during data collection by cross checking obstetric information verbally provided by women with the information on their ANC books. ANC books and hospital records were also used to determine the incidence of specific pregnancy outcomes among women participating in the program, particularly low birthweight, preterm delivery, and stillbirth. A semi-structured questionnaire containing a combination of statements and questions was distributed to women in the postnatal units and CWC at the Greater Accra Regional Hospital in order to identify enabling and hindering factors that may have an association with IPTp-SP uptake. Participating women were recruited from the waiting areas of their respective units before or after their appointments to ensure that their medical care was not interrupted or impeded by their participation in the study. For participants who didn't speak English, research assistants were present to translate the Participant Information Sheet and consent form, along with a witness. The questionnaire was used to collect data on sociodemographic factors and knowledge factors as well as health system characteristics that may serve as explanatory variables for IPTp-SP uptake. Research

assistants aided participants in filling out the questionnaire and translated the questions into a local language when needed. Questionnaires were administered to women who had recently given birth, but only to those who had delivered within the six months preceding their participation in the study.

It should be noted that two short supplementary questionnaires were administered to administrative workers and health workers respectively. The information collected is relevant to the SP stock levels at the Greater Accra Regional Hospital and the training that health workers at the facility have or have not received regarding the administration of SP. This information was collected via questionnaire because it is unavailable online, and the responses were used as supporting information in the discussion when applicable.

3.9 Quality Control

Questionnaires were pre-tested at Legon Hospital prior to the initiation of data collection. They were administered to ten women to allow for necessary adjustments to be made before the start of the data collection period. Throughout the study, questionnaires were reviewed by both the PI and hired research assistants to ensure that the questions were answered fully and appropriately before data analysis. Questionnaires were also reviewed at the time of collection to allow for corrections to be made by participating women while still at the healthcare facility.

3.10 Data Analysis

Stata 16 was used to manage and analyze the data. Descriptive statistics were used to analyze and describe the characteristics of the study population. The uptake of various IPT doses was estimated using percentages and the corresponding 95% confidence interval. Bivariate analysis was performed to assess the factors associated with IPT uptake, including minimal uptake (at least three doses) and optimal uptake (at least 5 doses) specifically. A binary logistic regression model was then used to identify the factors that are independently associated

with the minimal and optimal uptake of IPTp – estimating both the crude and adjusted odds ratios with their corresponding 95% confidence intervals and p-values.

The pregnancy outcomes (adverse pregnancy outcome, preterm birth, low birthweight and still birth) are described using pie charts that show the prevalence of each outcome and their corresponding 95% confidence intervals. The association between each of the pregnancy outcomes and the number of IPTp doses taken by the women was assessed via the Pearson chi-square test. The binary logistic regression model was used to assess the effect of the number of IPTp doses taken (no doses, <3 doses, 3-4 doses and 5+ doses) on adverse pregnancy outcomes, preterm birth, and low birthweight. The binary logistic regression model did not assess the effect of IPT on stillbirth due to the low prevalence of stillbirth among study participants.

Potential confounding variables considered in the adjusted model were those variables with p-values less than 0.20 from a bivariate analysis performed between the confounding variables and the pregnancy outcomes. The crude and adjusted odds ratios, along with the corresponding 95% confidence interval and p-values, are presented to assess the effect of IPTp on pregnancy outcomes. All statistical analysis was considered significant at the predetermined 0.050 level of significance.

3.11 Ethical Consideration

3.11.1 Ethical Approval

Ethical approval was obtained from the Ghana Health Service Ethics Review Committee prior to commencement of the study. The GHS-ERC reference number for the approved protocol is 032/10/22. Authorization to conduct the study at the Greater Accra Regional Hospital was received from the Medical Director of the facility.

3.11.2 Protocol

A cross-sectional study design was implemented and 385 women who gave birth within the six months preceding the study were interviewed. Research assistant(s) were recruited by

the principal investigator to help with questionnaire distribution and data collection from patient ANC books and hospital records at the Greater Accra Regional Hospital. A small number of supplementary questionnaires were filled out by administrators and health workers to help give the PI information on the stock of SP at the Greater Accra Regional Hospital and health workers' knowledge of IPTp-SP. Informed consent was obtained from all study participants and participant confidentiality was maintained throughout the study.

3.11.3 Potential Risks

The risks associated with participating in this study were minimal and no obvious discomforts were observed. COVID-19 protocols were observed by the PI and research assistants, and the time allotted for women to fill out the questionnaire was approximately five minutes.

3.11.4 Study Benefits

The results of this study may potentially be used by public health officials to learn about the current state of IPTp-SP administration in Ghana, which in turn may lead to improvements in the implementation IPTp-SP. Improved IPTp-SP implementation can ultimately reduce adverse pregnancy outcomes that occur as a result of severe malaria in pregnancy.

3.11.5 Confidentiality

All information obtained by researchers is strictly confidential and was only seen by the PI, research assistants, and the PI's academic supervisor. The PI made all efforts to ensure that participant confidentiality was maintained throughout the course of the study and beyond. The identities of participants were not recorded.

3.11.6 Compensation

There was no financial compensation for women who participated in the study, but each woman was given a small gift after completing the questionnaire as a token of appreciation.

3.11.7 Voluntary Participation and Withdrawal

Participation in this study was strictly voluntary and participants had the right to remove themselves from the study at any time.

3.11.8 Outcome and Feedback

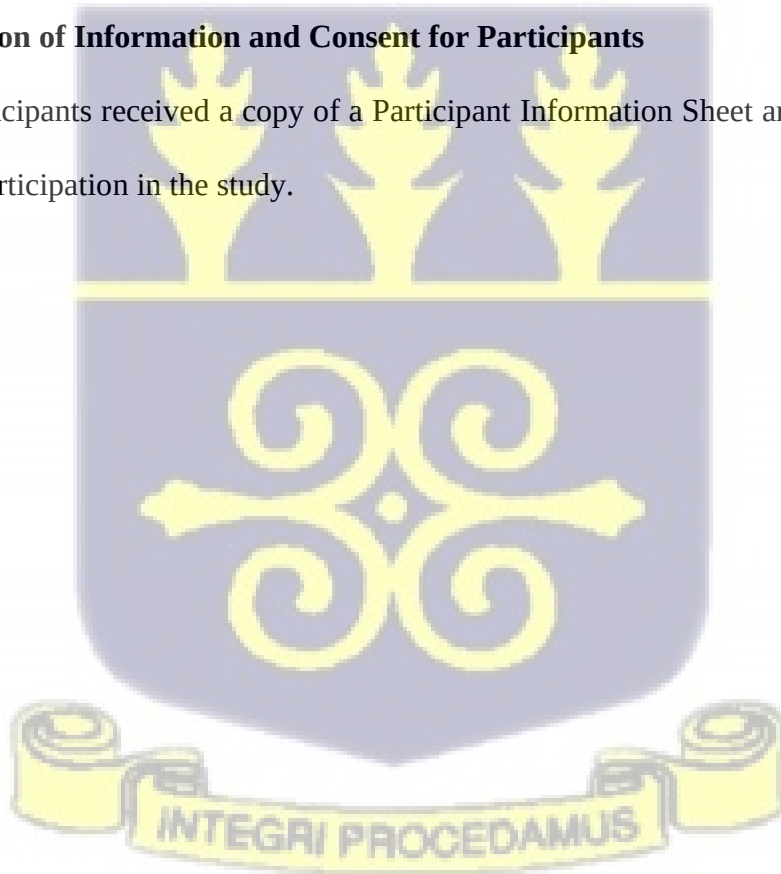
The results of this study are available to the appropriate parties, including the Medical Director of the facility as well as the Regional Health Directorate for the Greater Accra region. Participants who express interest in the outcome of the study were able to request feedback upon completion of the study.

3.11.9 Data Access and Storage

All data collected was securely stored by the PI, and password protection was utilized to ensure that computerized data can only be accessed by the PI.

3.11.10 Provision of Information and Consent for Participants

All participants received a copy of a Participant Information Sheet and Consent Form prior to their participation in the study.



CHAPTER 4: RESULTS

4.1 Sociodemographic Characteristics of Study Participants

Sociodemographic information, including participant age and place of birth, was collected for all 385 women who participated in this study and is shown in Table 1 below. Most participants were between 20-39 years old (95.3%), but a small number of women were between the ages of 18-19 and 40-49 (1% and 3.6% respectively). Nearly 75% of women were married at the time of the study and approximately 80% of women were from the Greater Accra Region in Ghana. More than 80% of the women said they were employed, and the majority of women had an education level of senior high school or higher (70.4%), but 30% recorded having only attended junior high school or less. The religious breakdown of participants was 75.6% Christian and 24.4% Muslim.

Table 1, shown below, also shows information related to the obstetric history of the women who participated in the study. Parity, which is the number of times a woman has given birth, ranged from 1-6, with 34% citing that their most recent pregnancy was their first-time giving birth. Only 3.1% of women waited until the third trimester to attend ANC (59.7% began during the first trimester and 37.1% during the second trimester), and three quarters of the study participants attended 8 or more ANC appointments during their pregnancies (Table 1).

Table 1: Socio-demographic characteristics of study participants

Characteristics	Total (N=385) n (%)
Age	
18-19	4 (1.0)
20-29	183 (47.5)
30-39	184 (47.8)
40-49	14 (3.6)
Marital Status	
Single	97 (25.2)
Married	288 (74.8)
Place of Birth	
Greater Accra Region	311 (80.8)
Other regions in Ghana	64 (16.6)
Other countries (Nigeria/Sierra Leone)	10 (2.6)
Education Level	
None	9 (2.3)
Primary School	19 (4.9)
Junior High School	86 (22.3)

Senior High School	134 (34.8)
Tertiary	137 (35.6)
Employment Status	
Unemployed	70 (18.2)
Employed	315 (81.8)
Religion	
Christian	291 (75.6)
Muslim	94 (24.4)
Parity, Median (IQR)	2 (1-2)
Parity	
1 child	131 (34.0)
2 children	159 (41.3)
3+ children	95 (24.7)
Trimester at First ANC Visit	
First Trimester	230 (59.7)
Second Trimester	143 (37.1)
Third Trimester	12 (3.1)
Number of ANC visits, Median (IQR)	9 (8-9)
Number of ANC visits	
<4 visits	7 (1.8)
4-7 visits	89 (23.1)
8+ visits	289 (75.1)

4.2 IPTp-SP Uptake among Study Participants

Table 2 shows the breakdown of IPTp-SP uptake among the women who participated in the study. Of the 385 total participants, 4.4% did not take any doses of IPT, 4.2% received only 1 dose of IPT, 6.5% received exactly 2 doses of IPT, 33.5% received exactly 3 doses of IPT, 23.6% received exactly 4 doses of IPT, 27.0% received exactly 5 doses of IPT, and 0.8% received more than five doses. Overall, 95.6% of the women received at least one dose of IPT, 84.9% recorded at least three doses (IPT3+), and 27.8% attained the optimal number of five or more doses of IPT (IPT5+). In other words, 15.1% of the women received less than three doses of IPT and 72.2% received less than 5 doses of IPT – this can be seen in Table 2.

Table 2: Uptake of IPTp among women

Number of IPTp doses	N (%)	95% CI
IPTp-SP Uptake		
No IPT	17 (4.4)	[2.8, 7.0]
IPT1	16 (4.2)	[2.6, 6.7]
IPT2	25 (6.5)	[4.4, 9.4]
IPT3	129 (33.5)	[29.0, 38.4]
IPT4	91 (23.6)	[19.7, 28.2]
IPT5	104 (27.0)	[22.8, 31.7]
IPT6+	3 (0.8)	[0.3, 2.4]
At least one dose	368 (95.6)	[93.0, 97.2]
Below required dose (<3 doses)	58 (15.1)	[11.8, 19.0]
Required doses (3+ doses)	327 (84.9)	[81.0, 88.2]

Sub-optimal dose (<5 doses)	278 (72.2)	[67.5, 76.5]
Optimal dose (5+ doses)	107 (27.8)	[23.5, 32.5]

CI: confidence interval

4.3 Factors Associated with the Overall Uptake of IPTp-SP

In the bivariate analysis shown in Table 3, the association between different sociodemographic variables and the outcome variable, IPT uptake (no IPT, less than 3 doses, 3-4 doses, and 5 or more doses), is analysed. A significant association was found between marital status and the number of IPT doses taken, as indicated by a p-value of 0.038. Of the 97 single women that participated in the study, 9.3% did not take any IPT and only 22.7% received at least five doses. In contrast, 2.8% of married women didn't take any IPT and 29.5% of them received IPT5+. A significant association was also found between the number of IPT doses taken and both the trimester at first ANC visit and the number of ANC visits attended ($p < 0.001$ respectively). None of the women whose initial ANC appointment occurred during the third trimester received IPT5 (0.0%), as compared to the 27.3% of women who began attending ANC during their second trimester and the 29.6% of women who began visiting ANC during their first trimester (Table 3)

A similar trend was seen among those who received sub-optimal doses (IPT3 and IPT4) – 51.7% of women whose first ANC appointment was during the second trimester were able to get IPT3-4 compared to the 60.9% of women who began attending ANC during the first trimester. A notable difference can also be seen in IPT uptake according to the number of ANC visits attended. Optimal uptake (IPT5+) occurred at a greater percentage for those who attended 8 or more ANC appointments (34.6%), whereas only 7.9% of women who attended 4-7 visits and none of the women who attended less than four times achieved five or more doses. Women who attended 4-7 or 8+ ANC visits had higher percentages of IPT3-4 and IPT5+ and lower percentages of no IPT and IPT1-2 compared to women with less than 4 ANC visits (Table 3).

Table 3: Bivariate association between socio-demographic characteristics and the number of IPTp dose

	Number of IPTp doses taken				Statistic	p-value
	No dose (N=17) n/N (%)	1-2 doses (N=41) n/N (%)	3-4 doses (N=220) n/N (%)	5+ doses (N=107) n/N (%)		
Age					Chi2(9) = 4.60	0.870
18-19	0/4 (0.0)	1/4 (25.0)	3/4 (75.0)	0/4 (0.0)		
20-29	7/183 (3.8)	21/183 (11.5)	102/183 (55.7)	53/183 (29.0)		
30-39	10/184 (5.4)	17/184 (9.2)	106/184 (57.6)	51/184 (27.7)		
40-49	0/14 (0.0)	2/14 (14.3)	9/14 (64.3)	3/14 (21.4)		
Marital Status					Chi2(3) = 8.45	0.038
Single	9/97 (9.3)	9/97 (9.3)	57/97 (58.8)	22/97 (22.7)		
Married	8/288 (2.8)	32/288 (11.1)	163/288 (56.6)	85/288 (29.5)		
Place of Birth					Chi2(6) = 2.81	0.830
Greater Accra Region	15/311 (4.8)	32/311 (10.3)	178/311 (57.2)	86/311 (27.7)		
Other regions in Ghana	2/64 (3.1)	7/64 (10.9)	38/64 (59.4)	17/64 (26.6)		
Other countries (Nigeria/Sierra Leone)	0/10 (0.0)	2/10 (20.0)	4/10 (40.0)	4/10 (40.0)		
Education Level					Chi2(12) = 11.24	0.510
None	0/9 (0.0)	1/9 (11.1)	4/9 (44.4)	4/9 (44.4)		
Primary School	2/19 (10.5)	2/19 (10.5)	13/19 (68.4)	2/19 (10.5)		
Junior High School	4/86 (4.7)	10/86 (11.6)	54/86 (62.8)	18/86 (20.9)		
Senior High School	7/134 (5.2)	15/134 (11.2)	76/134 (56.7)	36/134 (26.9)		
Tertiary	4/137 (2.9)	13/137 (9.5)	73/137 (53.3)	47/137 (34.3)		
Employment Status					Chi2(3) = 4.29	0.230
Unemployed	4/70 (5.7)	11/70 (15.7)	41/70 (58.6)	14/70 (20.0)		
Employed	13/315 (4.1)	30/315 (9.5)	179/315 (56.8)	93/315 (29.5)		
Religion					Chi2(3) = 3.27	0.350
Christian	12/291 (4.1)	35/291 (12.0)	161/291 (55.3)	83/291 (28.5)		
Muslim	5/94 (5.3)	6/94 (6.4)	59/94 (62.8)	24/94 (25.5)		
Parity					Chi2(6) = 4.36	0.630
1 child	7/131 (5.3)	16/131 (12.2)	72/131 (55.0)	36/131 (27.5)		
2 children	4/159 (2.5)	14/159 (8.8)	98/159 (61.6)	43/159 (27.0)		
3+ children	6/95 (6.3)	11/95 (11.6)	50/95 (52.6)	28/95 (29.5)		
Trimester at First ANC Visit					Chi2(6) = 32.04	<0.001
First Trimester	6/230 (2.6)	16/230 (7.0)	140/230 (60.9)	68/230 (29.6)		
Second Trimester	11/143 (7.7)	19/143 (13.3)	74/143 (51.7)	39/143 (27.3)		
Third Trimester	0/12 (0.0)	6/12 (50.0)	6/12 (50.0)	0/12 (0.0)		
Number of ANC visits					Chi2(6) = 70.19	<0.001
<4 visits	1/7 (14.3)	5/7 (71.4)	1/7 (14.3)	0/7 (0.0)		
4-7 visits	7/89 (7.9)	20/89 (22.5)	55/89 (61.8)	7/89 (7.9)		
8+ visits	9/289 (3.1)	16/289 (5.5)	164/289 (56.7)	100/289 (34.6)		

The data shown in Table 4, on the other hand, reflects the bivariate association that exists between IPT uptake and malaria knowledge and preventive practices. A statistically significant association was found between IPT uptake and the women's knowledge that malaria in pregnancy can lead to negative pregnancy outcomes including preterm delivery, low birthweight, and stillbirth. While 74.1% of women who received IPT3-4 and 72.0% of women who received IPT5+ were knowledgeable about this, less than 50% of the women who received IPT1-2 or no IPT knew that malaria in pregnancy could lead to negative outcomes (Table 4).

The percentage of women who did nothing to prevent malaria during their pregnancy was greater among those who received no doses (29.4%) or only 1-2 doses (14.6%), and the percentage of women who said they took antimalarial drugs, when asked what they did to prevent malaria during pregnancy, was higher among those who received more doses of IPT (35.0% for IPT3-4 and 42.1% for IPT5+). Table 4 also shows that knowledge of what IPTp-SP stands for and its timing tended to be greater among those who received adequate and optimal doses of SP (IPT3-4 and IPT5+).

There were only 8 women out of the 385 total participants that knew that IPT stood for "intermittent preventive treatment", and all these women received at least 3 doses of SP during pregnancy. More than half of the women with IPT5+ knew that the recommendation is to at least take three doses of SP (52.3%), while the majority of those with IPT1-2 or no IPT did not know the recommendation (78.0 and 82.4% respectively). Significant associations were also seen between IPT uptake and the experience of side effects after taking SP ($p < 0.001$), the use of an ITN while sleeping ($p = 0.037$), and knowledge that ITNs can prevent malaria during pregnancy ($p = 0.001$). This data can be found in the table below (Table 4).

Table 4: Bivariate association between knowledge and practices of women and the number of IPTp dose

	Number of IPTp doses taken				Statistic	p-value
	No dose (N=17) n/N (%)	1-2 doses (N=41) n/N (%)	3-4 doses (N=220) n/N (%)	5+ doses (N=107) n/N (%)		
Knowledge factors						
Knows that pregnant women are at greater risk of contracting severe malaria	11/17 (64.7)	27/41 (65.9)	170/220 (77.3)	87/107 (81.3)	Chi2(3) = 5.37	0.150
Knows that malaria in pregnancy can lead to negative pregnancy outcomes, including preterm delivery, low birthweight, and stillbirth	8/17 (47.1)	19/41 (46.3)	163/220 (74.1)	77/107 (72.0)	Chi2(3) = 16.86	<0.001
Knows that malaria can be transmitted to the foetus during pregnancy	12/17 (70.6)	25/41 (61.0)	139/220 (63.2)	75/107 (70.1)	Chi2(3) = 2.06	0.560
Actions taken to prevent malaria during pregnancy						
Nothing	5/17 (29.4)	6/41 (14.6)	16/220 (7.3)	8/107 (7.5)	Chi2(3) = 11.24	0.011
Slept under ITN	8/17 (47.1)	24/41 (58.5)	116/220 (52.7)	50/107 (46.7)	Chi2(3) = 2.05	0.560
Sprayed room (IRS)	0/17 (0.0)	0/41 (0.0)	0/220 (0.0)	0/107 (0.0)		
Stayed indoors	0/17 (0.0)	2/41 (4.9)	5/220 (2.3)	2/107 (1.9)	Chi2(3) = 1.67	0.640
Kept windows closed	0/17 (0.0)	0/41 (0.0)	2/220 (0.9)	0/107 (0.0)	Chi2(3) = 1.51	0.680
Took antimalarial drugs	1/17 (5.9)	11/41 (26.8)	77/220 (35.0)	45/107 (42.1)	Chi2(3) = 9.90	0.019
Mosquito sprays	2/17 (11.8)	3/41 (7.3)	12/220 (5.5)	6/107 (5.6)	Chi2(3) = 1.28	0.730
Knows what IPT stands for?	0/17 (0.0)	0/41 (0.0)	2/220 (0.9)	6/107 (5.6)	Chi2(3) = 9.26	0.026
Knows what time is recommended for pregnant women to start taking SP	0/17 (0.0)	4/41 (9.8)	15/220 (6.8)	18/107 (16.8)	Chi2(3) = 10.19	0.017
Knows how much time should pass between SP doses	1/17 (5.9)	8/41 (19.5)	55/220 (25.0)	33/107 (30.8)	Chi2(3) = 5.88	0.120
Number of doses of SP recommended during pregnancy					Chi2(6) = 21.02	0.002
<3 doses	0/17 (0.0)	1/41 (2.4)	2/220 (0.9)	2/107 (1.9)		
3+ doses	3/17 (17.6)	8/41 (19.5)	76/220 (34.5)	56/107 (52.3)		
Don't know	14/17 (82.4)	32/41 (78.0)	142/220 (64.5)	49/107 (45.8)		
Knows of any side effects associated with taking SP?	4/17 (23.5)	11/41 (26.8)	80/220 (36.4)	50/107 (46.7)	Chi2(3) = 7.40	0.060
Experience any negative side effects after taking SP?					Chi2(6) = 307.12	<0.001
No	2/17 (11.8)	28/41 (68.3)	157/220 (71.4)	58/107 (54.2)		
Yes	0/17 (0.0)	13/41 (31.7)	61/220 (27.7)	49/107 (45.8)		
N/A	15/17 (88.2)	0/41 (0.0)	2/220 (0.9)	0/107 (0.0)		
Slept under an insecticide treated mosquito net (ITN) during most recent pregnancy	9/17 (52.9)	27/41 (65.9)	158/220 (71.8)	61/107 (57.0)	Chi2(3) = 8.48	0.037
Knows that sleeping under an insecticide treated mosquito net (ITN) can help prevent malaria during pregnancy	14/17 (82.4)	34/41 (82.9)	212/220 (96.4)	102/107 (95.3)	Chi2(3) = 15.58	0.001
Diagnosed with malaria during your most recent pregnancy	1/17 (5.9)	5/41 (12.2)	12/220 (5.5)	10/107 (9.3)	Chi2(3) = 3.28	0.350

Additionally, Table 5 shows the bivariate association between health system/accessibility factors and IPT uptake, categorized as no IPT, inadequate IPT (IPT1-2), adequate uptake (IPT3-4) and optimal uptake (IPT5+). All but two participants stated that SP was available at their ANC visits when needed, and the majority of participants who took SP reported taking it under the supervision of a health worker as a DOT (349/368). The percentage of women who said they took SP outside of the health facility was low overall but was notably highest among those with only 1-2 doses of IPT (7.3%, $p<0.001$).

A significant association with IPT uptake was found with questions 2-5 in the Table 5; however, it should be noted that this significance likely stems from the presence of the “N/A” answer option which was 100% for those who took no IPT. Compared to those with IPT3+, a greater percentage of those with no IPT or IPT1-2 agreed that the cost of transportation made it more difficult to attend ANC appointments (23.5% and 43.9% respectively, $p=0.006$) and that it was difficult to find transportation to ANC appointments (11.8% and 26.8% respectively, $p=0.023$). Also statistically significant is the association between IPT uptake and the number of women who felt that the wait time to receive ANC is too long, with the highest percentage of those who agreed being among the women who did not take IPT (64.7%, $p=0.05$). Women were also asked if the COVID-19 pandemic made it more difficult to attend ANC appointments, but a statistically association was not found between this and the number of IPT doses attained.

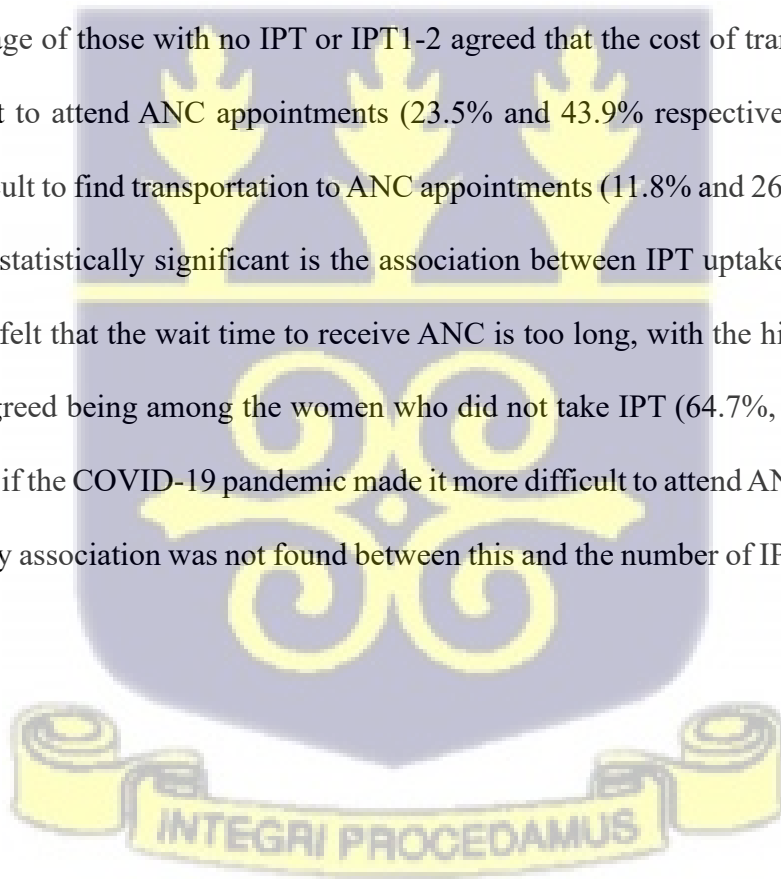


Table 5: Bivariate association between health system factors and the number of IPTp dose

	Number of IPTp doses taken				Statistic	p-value
	No dose (N=17) n/N (%)	1-2 doses (N=41) n/N (%)	3-4 doses (N=220) n/N (%)	5+ doses (N=107) n/N (%)		
Registered under the National Health Insurance Scheme?					Chi2(3) = 5.16	0.16
No	2/17 (11.8)	1/41 (2.4)	5/220 (2.3)	3/107 (2.8)		
Yes	15/17 (88.2)	40/41 (97.6)	215/220 (97.7)	104/107 (97.2)		
Was SP available at each ANC visit when needed?					Chi2(6) = 386.42	<0.001
No	0/17 (0.0)	0/41 (0.0)	2/220 (0.9)	0/107 (0.0)		
Yes	0/17 (0.0)	41/41 (100.0)	218/220 (99.1)	107/107 (100.0)		
N/A	17/17 (100.0)	0/41 (0.0)	0/220 (0.0)	0/107 (0.0)		
Took the SP tablets under the supervision of a health worker (DOT)?					Chi2(6) = 385.91	<0.001
No	0/17 (0.0)	3/41 (7.3)	12/220 (5.5)	4/107 (3.7)		
Yes	0/17 (0.0)	38/41 (92.7)	208/220 (94.5)	103/107 (96.3)		
N/A	17/17 (100.0)	0/41 (0.0)	0/220 (0.0)	0/107 (0.0)		
How did you obtain water to take the SP tablets?					Chi2(9) = 388.28	<0.001
I brought water with me	0/17 (0.0)	15/41 (36.6)	93/220 (42.3)	36/107 (33.6)		
I had to go buy water	0/17 (0.0)	25/41 (61.0)	123/220 (55.9)	67/107 (62.6)		
The facility provided it	0/17 (0.0)	1/41 (2.4)	4/220 (1.8)	4/107 (3.7)		
N/A	17/17 (100.0)	0/41 (0.0)	0/220 (0.0)	0/107 (0.0)		
Did you take the SP tablets inside or outside of the health facility?					Chi2(3) = 167.50	<0.001
Inside	0/17 (0.0)	38/41 (92.7)	209/220 (95.0)	101/107 (94.4)		
Outside	17/17 (100.0)	3/41 (7.3)	11/220 (5.0)	6/107 (5.6)		
Cost of transportation made it difficult to attend ANC appointments.					Chi2(3) = 12.62	0.006
Agree	4/17 (23.5)	18/41 (43.9)	41/220 (18.6)	24/107 (22.4)		
Disagree/neutral	13/17 (76.5)	23/41 (56.1)	179/220 (81.4)	83/107 (77.6)		
Difficult to find transportation to ANC appointments.					Chi2(3) = 9.52	0.023
Agree	2/17 (11.8)	11/41 (26.8)	21/220 (9.5)	15/107 (14.0)		
Disagree/neutral	15/17 (88.2)	30/41 (73.2)	199/220 (90.5)	92/107 (86.0)		
The road network made it difficult to attend ANC appointments					Chi2(3) = 4.28	0.23
Agree	8/17 (47.1)	18/41 (43.9)	69/220 (31.4)	41/107 (38.3)		
Disagree/neutral	9/17 (52.9)	23/41 (56.1)	151/220 (68.6)	66/107 (61.7)		
I feel that ANC services are too expensive.					Chi2(3) = 5.91	0.12
Agree	4/17 (23.5)	3/41 (7.3)	16/220 (7.3)	12/107 (11.2)		
Disagree/neutral	13/17 (76.5)	38/41 (92.7)	204/220 (92.7)	95/107 (88.8)		
During my last pregnancy, the wait time to receive ANC was too long.					Chi2(3) = 7.79	0.050
Agree	11/17 (64.7)	19/41 (46.3)	91/220 (41.4)	59/107 (55.1)		
Disagree/neutral	6/17 (35.3)	22/41 (53.7)	129/220 (58.6)	48/107 (44.9)		
The COVID-19 pandemic made it more difficult to attend ANC					Chi2(3) = 0.97	0.81

Agree	2/17 (11.8)	6/41 (14.6)	37/220 (16.8)	14/107 (13.1)
Disagree/neutral	15/17 (88.2)	35/41 (85.4)	183/220 (83.2)	93/107 (86.9)



4.4 Factors Associated with Uptake of at Least Three Doses of IPT

The number of women who took at least three doses of IPT (IPT3+) includes those who took exactly three doses (IPT3), those who took exactly 4 doses (IPT4), and those who took five or more doses (IPT5+). According to Table 6, more ANC visits was associated with increased IPT3+ uptake, with 91.3% of women with 8 or more visits having taken IPT3+ compared to the 69.7% with 4-7 visits and the 14.3% with less than 4 visits ($p<0.001$). Women who attended ANC appointments 8 or more times were 55 times more likely to take IPT3+ compared to those who attended ANC less than 4 times (AOR=55.96, CI=2.69-1162.4, $p=0.009$), whilst women who attended 4-7 ANC appointments were 15 times more likely to take IPT3+ compared to those who attended less than 4 times (AOR=15.32, CI=0.70-336.4, $p=0.083$).

Of the 123 women who experienced side effects, 89.4% achieved IPT3+. Conversely, 87.8% of women who did not experience side effects when taking IPT took IPT3+. Additionally, it was found that those who took SP outside of the health facility were 0.2 times likely to reach IPT3+ (AOR=0.2, CI=0.06-0.67, $p=0.009$) compared to those who took the drug inside of the health facility. Compared to those who did not know, the results also show that there were higher percentages of IPT3+ uptake among women who indicated that they knew pregnant women are at greater risk of severe malaria (87.1%, $p=0.30$), that malaria in pregnancy can lead to negative pregnancy outcomes (89.9%, $p<0.001$), and that sleeping under an ITN can help prevent malaria (86.7%, $p<0.001$).

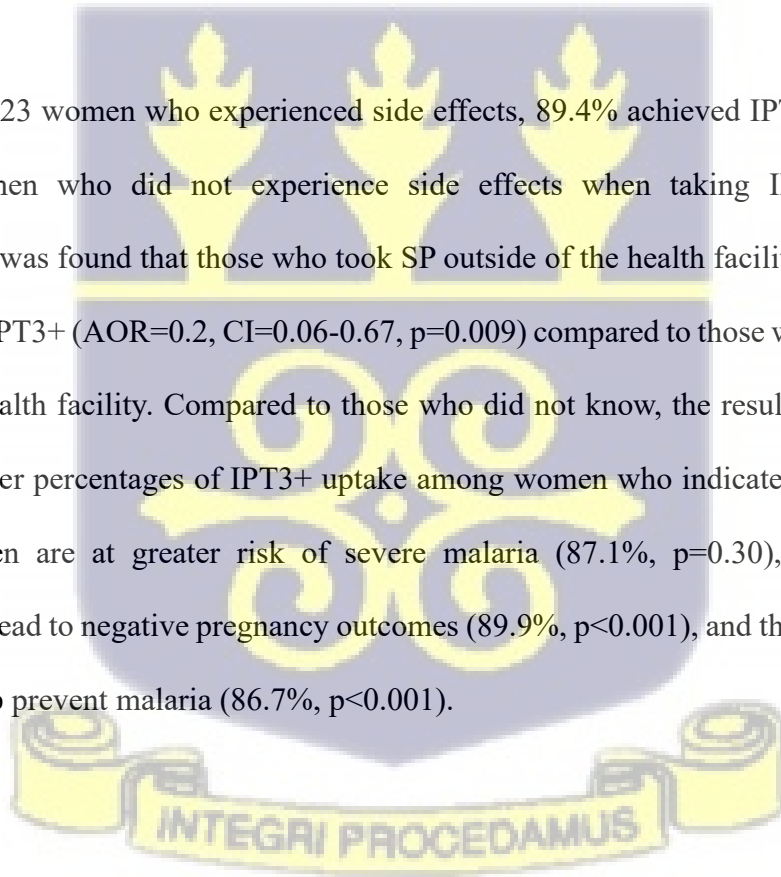


Table 6: Factors associated with uptake of minimal dose of IPTp during pregnancy

Characteristics	Bivariate association			Binary logistic regression model			
	3+ IPTp doses n/N (%)	Statistics	P-value	Unadjusted model cOR [95% CI]	P-value	Adjusted model aOR [95% CI]	P-value
Number of ANC visits		Chi2(2) = 52.82	<0.001				
<4 visits	1/7 (14.3)			1.00 [reference]		1.00 [reference]	
4-7 visits	62/89 (69.7)			13.78 [1.58, 120.37]	0.018	15.32 [0.70, 336.42]	0.083
8+ visits	264/289 (91.3)			63.36 [7.31, 548.95]	<0.001	55.96 [2.69, 1162.40]	0.009
Knows that pregnant women are at greater risk of contracting severe malar		Chi2(1) = 4.70	0.030				
No	70/90 (77.8)			1.00 [reference]		1.00 [reference]	
Yes	257/295 (87.1)			1.93 [1.06, 3.53]	0.032	0.77 [0.32, 1.82]	0.550
Knows that malaria in pregnancy can lead to negative pregnancy outcomes,		Chi2(1) = 16.70	<0.001				
No	87/118 (73.7)			1.00 [reference]		1.00 [reference]	
Yes	240/267 (89.9)			3.17 [1.79, 5.61]	<0.001	2.23 [0.90, 5.52]	0.082
Action to prevent malaria: Nothing		Chi2(1) = 8.06	0.005				
No	303/350 (86.6)			1.00 [reference]		1.00 [reference]	
Yes	24/35 (68.6)			0.34 [0.16, 0.74]	0.006	1.16 [0.33, 4.10]	0.819
Action to prevent malaria: Took antimalarial drugs		Chi2(1) = 6.00	0.014				
No	205/251 (81.7)			1.00 [reference]		1.00 [reference]	
Yes	122/134 (91.0)			2.28 [1.16, 4.48]	0.017	1.85 [0.77, 4.47]	0.169
Knows how much time should pass between SP doses		Chi2(1) = 3.39	0.065				
No	239/288 (83.0)			1.00 [reference]		1.00 [reference]	
Yes	88/97 (90.7)			2.00 [0.94, 4.25]	0.070	0.62 [0.25, 1.52]	0.297
Number of doses of SP recommended during pregnancy		Chi2(2) = 9.67	0.008				
<3 doses	4/5 (80.0)			1.00 [reference]		1.00 [reference]	
3+ doses	132/143 (92.3)			3.00 [0.31, 29.30]	0.345	3.40 [0.30, 38.35]	0.322
Don't know	191/237 (80.6)			1.04 [0.11, 9.54]	0.974	1.74 [0.17, 18.06]	0.642
Knows of any side effects associated with taking SP		Chi2(1) = 4.05	0.044				
No	197/240 (82.1)			1.00 [reference]		1.00 [reference]	
Yes	130/145 (89.7)			1.89 [1.01, 3.55]	0.047	1.53 [0.55, 4.22]	0.414
Experienced any negative side effects after taking SP		Chi2(2) = 74.60	<0.001				

No	215/245 (87.8)			1.00 [reference]		1.00 [reference]	
Yes	110/123 (89.4)			1.18 [0.59, 2.36]	0.638	0.96 [0.36, 2.58]	0.938
N/A	2/17 (11.8)			0.02 [0.00, 0.09]	<0.001	0.04 [0.01, 0.26]	0.001
Knows that sleeping under an insecticide treated mosquito net (ITN) can help prevent malaria							
No	13/23 (56.5)	Chi2(1) = 15.43	<0.001	1.00 [reference]		1.00 [reference]	
Yes	314/362 (86.7)			5.03 [2.09, 12.13]	<0.001	1.87 [0.43, 8.08]	0.404
Took the SP tablets inside or outside of the health facility							
Inside	310/348 (89.1)	Chi2(1) = 48.63	<0.001	1.00 [reference]		1.00 [reference]	
Outside	17/37 (45.9)			0.10 [0.05, 0.22]	<0.001	0.20 [0.06, 0.67]	0.009
Cost of transportation made it difficult for me to attend ANC appointments.							
Agree	65/87 (74.7)	Chi2(1) = 9.18	0.002	1.00 [reference]		1.00 [reference]	
Disagree/neutral	262/298 (87.9)			2.46 [1.36, 4.47]	0.003	1.71 [0.72, 4.07]	0.228
It is difficult to find transportation to ANC appointments.							
Agree	36/49 (73.5)	Chi2(1) = 5.77	0.016	1.00 [reference]		1.00 [reference]	
Disagree/neutral	291/336 (86.6)			2.34 [1.15, 4.74]	0.019	1.77 [0.57, 5.54]	0.323
The road network made it difficult to attend ANC							
Agree	110/136 (80.9)	Chi2(1) = 2.70	0.10	1.00 [reference]		1.00 [reference]	
Disagree/neutral	217/249 (87.1)			1.60 [0.91, 2.83]	0.103	1.37 [0.62, 3.06]	0.437
I feel that ANC services are too expensive.							
Agree	28/35 (80.0)	Chi2(1) = 0.73	0.39	1.00 [reference]		1.00 [reference]	
Disagree/neutral	299/350 (85.4)			1.47 [0.61, 3.54]	0.395	0.31 [0.06, 1.56]	0.154

cOR: crude odds ratio. aOR: adjusted odds ratio. CI: confidence interval



4.5 Factors Associated with Uptake of at Least Five Doses of IPT

The number of women who took at least five doses of IPT (IPT5+) includes those that took exactly 5 doses (IPT5) and those who took more than 5 doses. Of the women who knew when it is recommended to begin taking SP during pregnancy, 48.6% achieved IPT5+. Of the women who knew that three or more doses of SP are recommended during pregnancy, 39.2% reached IPT5+ (Table 7). Women who experienced side effects after taking SP were 2.15 times more likely to reach IPT5+ than women who had never experienced side effects (AOR=2.15, CI=1.10-4.17, $p=0.024$). Binary logistic regression modelling also revealed a statistically significant association between IPT5+ uptake and sleeping under an ITN during pregnancy. Those who slept under an ITN were 50% less likely to achieve IPT5+ (AOR=0.50, CI=0.30-0.84, $p=0.009$).



Table 7: Factors associated with uptake of optimal dose of IPTp during pregnancy

Characteristics	Bivariate association			Binary logistic regression model			
	5+ IPTp doses n/N (%)	Statistic	p-value	Unadjusted model cOR [95% CI]	P-value	Adjusted model aOR [95% CI]	P-value
Marital Status		Chi2(1) = 1.69	0.19				
Single	22/97 (22.7)			1.00 [reference]		1.00 [reference]	
Married	85/288 (29.5)			1.43 [0.83, 2.45]	0.196	1.07 [0.60, 1.92]	0.822
Employment Status		Chi2(1) = 2.59	0.11				
Unemployed	14/70 (20.0)			1.00 [reference]		1.00 [reference]	
Employed	93/315 (29.5)			1.68 [0.89, 3.16]	0.111	1.53 [0.75, 3.11]	0.241
Knows that pregnant women are at greater risk of contracting severe malar		Chi2(1) = 1.82	0.18				
No	20/90 (22.2)			1.00 [reference]		1.00 [reference]	
Yes	87/295 (29.5)			1.46 [0.84, 2.56]	0.180	1.42 [0.73, 2.79]	0.301
Action taken to prevent malaria: Took antimalarial drugs		Chi2(1) = 3.43	0.064				
No	62/251 (24.7)			1.00 [reference]		1.00 [reference]	
Yes	45/134 (33.6)			1.54 [0.97, 2.44]	0.065	1.06 [0.62, 1.82]	0.837
Knows what time is recommended for pregnant women to start taking SP		Chi2(1) = 8.87	0.003				
No	89/348 (25.6)			1.00 [reference]		1.00 [reference]	
Yes	18/37 (48.6)			2.76 [1.38, 5.49]	0.004	1.76 [0.74, 4.17]	0.199
Knows how much time should pass between SP doses		Chi2(1) = 2.51	0.11				
No	74/288 (25.7)			1.00 [reference]		1.00 [reference]	
Yes	33/97 (34.0)			1.49 [0.91, 2.45]	0.115	0.68 [0.36, 1.28]	0.234
How many doses of SP are recommended during pregnancy?)		Chi2(2) = 15.56	<0.001				
<3 doses	2/5 (40.0)			1.00 [reference]		1.00 [reference]	
3+ doses	56/143 (39.2)			0.97 [0.16, 5.98]	0.970	0.99 [0.18, 5.39]	0.992
Don't know	49/237 (20.7)			0.39 [0.06, 2.41]	0.312	0.46 [0.08, 2.62]	0.382
Knows of any side effects associated with taking SP?		Chi2(1) = 5.19	0.023				
No	57/240 (23.8)			1.00 [reference]		1.00 [reference]	
Yes	50/145 (34.5)			1.69 [1.07, 2.66]	0.024	0.98 [0.50, 1.90]	0.942
Experienced any negative side effects after taking SP		Chi2(2) = 17.51	<0.001				

No	58/245 (23.7)			1.00 [reference]		1.00 [reference]	
Yes	49/123 (39.8)			2.13 [1.34, 3.40]	0.001	2.15 [1.10, 4.17]	0.024
N/A	0/17 (0.0)			1.00 [0.00, 0.00]		1.00 [0.00, 0.00]	
Slept under an insecticide treated mosquito net (ITN) during your most recent pregnancy		Chi2(1) = 5.64	0.018				
No	46/130 (35.4)			1.00 [reference]		1.00 [reference]	
Yes	61/255 (23.9)			0.57 [0.36, 0.91]	0.018	0.50 [0.30, 0.84]	0.009
Took the SP tablets inside or outside of the health facility		Chi2(1) = 2.73	0.098				
Inside	101/348 (29.0)			1.00 [reference]		1.00 [reference]	
Outside	6/37 (16.2)			0.47 [0.19, 1.17]	0.105	0.45 [0.19, 1.11]	0.084
During my last pregnancy, the wait time to receive ANC was too long.		Chi2(1) = 4.19	0.041				
Agree	59/180 (32.8)			1.00 [reference]		1.00 [reference]	
Disagree/neutral	48/205 (23.4)			0.63 [0.40, 0.98]	0.042	0.70 [0.42, 1.17]	0.172

cOR: crude odds ratio. aOR: adjusted odds ratio. CI: confidence interval



4.6 IPTp-SP Uptake and Pregnancy Outcomes

4.6.1 Proportion of Pregnancy Outcomes among Study Participants

Figure 1 below, along with Table 8, presents pregnancy outcomes in four categories: overall pregnancy outcome (positive outcome or adverse outcome), birthweight (normal or low), gestational age at birth (term or preterm), and live status (livebirth or stillbirth). Of the 385 pregnancies recorded, 18.7% resulted in adverse pregnancy outcomes – more specifically, 14.5% of pregnancies resulted in low birthweight, 7.5% were preterm delivery, and 0.3% were stillbirth.

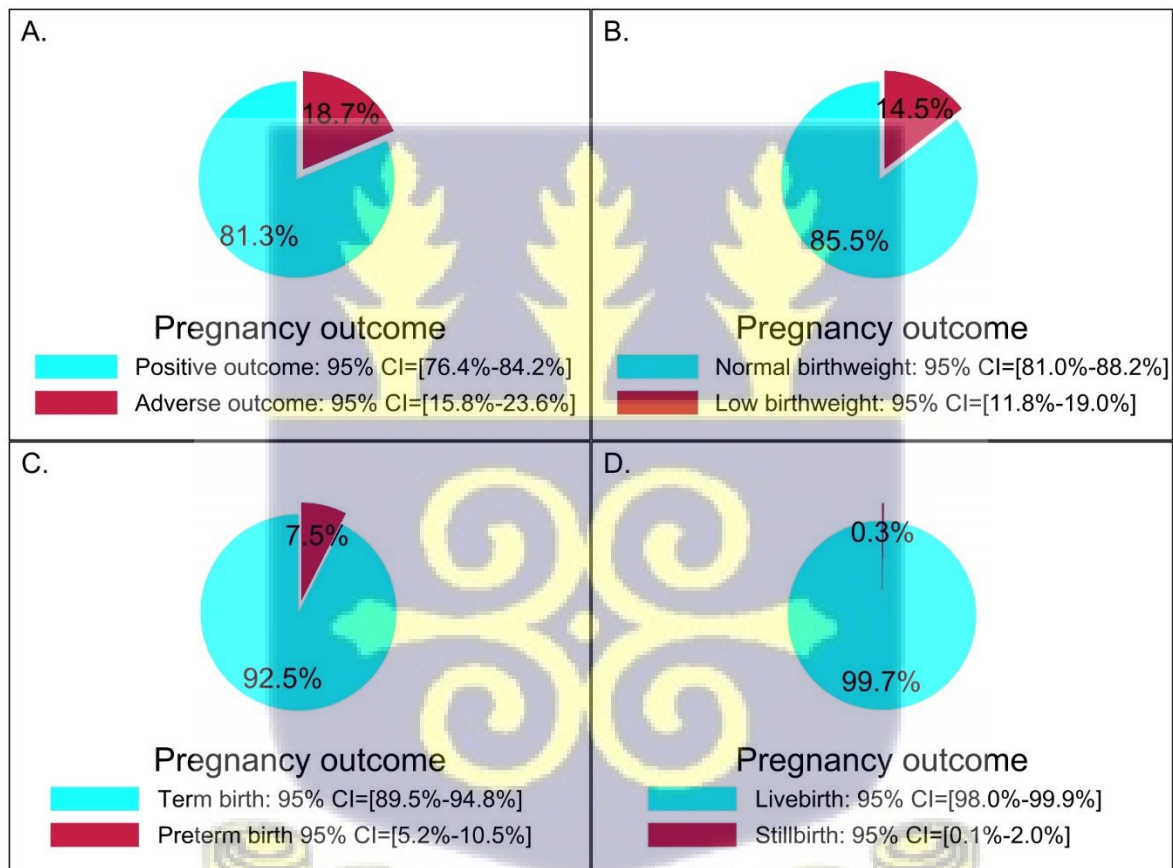


Figure 2: Pregnancy Outcomes among Study Participants

Table 8 looks at the association between IPT uptake and pregnancy outcomes. IPT uptake is classified as no IPT, inadequate doses (1-2 doses), sub-optimal doses (3-4 doses), and optimal doses (IPT5+). A statistically significant association was found between overall

pregnancy outcome and IPT dosage, with only 4.7% of those with five or more doses (optimal doses) experiencing an adverse pregnancy outcome compared to the 12.7% of those with only 3-4 doses (sub-optimal doses), 75.6% of those with only 1-2 doses (inadequate doses), and 47.1% of those with no IPT ($p<0.001$). The association between IPT uptake and birthweight was found to be statistically significant ($p<0.001$). Those with higher IPT uptake had lower percentages of low birthweight outcomes (2.8% for IPT5+, 9.5% for IPT3-4) compared to those with inadequate or no IPT (63.4% for IPT1-2, 35.3% for no IPT). Similar results were found for gestational age at birth: only 1.9% of women who took IPT5+ had a preterm delivery, whereas 5.0% of deliveries occurred preterm for women with IPT3-4, 31.7% for those with IPT1-2, and 17.6% for those who did not take IPT. There was no significant association between IPT dosage and the live status of the babies, and only 1 stillbirth was recorded (Table 8).



Table 8: Association between birth outcomes and number of IPTp taken during pregnancy

Pregnancy outcomes	Total N=385	Number of IPTp doses taken				Statistic	p-value
		No doses N=17	1-2 doses N=41	3-4 doses N=220	5+ doses N=107		
Overall pregnancy assessment						Chi2(3) = 115.34	<0.001
Positive pregnancy outcome	313/385 (81.3)	9/17 (52.9)	10/41 (24.4)	192/220 (87.3)	102/107 (95.3)		
Adverse pregnancy outcome	72/385 (18.7)	8/17 (47.1)	31/41 (75.6)	28/220 (12.7)	5/107 (4.7)		
Birth weight						Chi2(3) = 100.96	<0.001
Normal birthweight	329/385 (85.5)	11/17 (64.7)	15/41 (36.6)	199/220 (90.5)	104/107 (97.2)		
Low birthweight	56/385 (14.5)	6/17 (35.3)	26/41 (63.4)	21/220 (9.5)	3/107 (2.8)		
Gestational age at birth						Chi2(3) = 43.85	<0.001
Termed birth	356/385 (92.5)	14/17 (82.4)	28/41 (68.3)	209/220 (95.0)	105/107 (98.1)		
Preterm birth	29/385 (7.5)	3/17 (17.6)	13/41 (31.7)	11/220 (5.0)	2/107 (1.9)		
Live status of baby						Chi2(3) = 0.75	0.86
Livebirth	384/385 (99.7)	17/17 (100.0)	41/41 (100.0)	219/220 (99.5)	107/107 (100.0)		
Stillbirth	1/385 (0.3)	0/17 (0.0)	0/41 (0.0)	1/220 (0.5)	0/107 (0.0)		



4.6.2 Association between IPTp Uptake and Adverse Pregnancy Outcomes

For the women who took only 1-2 doses of IPT, 67.2% experienced an adverse pregnancy outcome, as compared to 12.7% adverse pregnancy outcomes among those with IPT3-4 and 4.7% among those who achieved IPT5+ (Table 9). Women who received 3-4 doses of IPT were found to be 96% less likely to have an adverse pregnancy outcome (AOR=0.04, CI=0.01-0.10, $p<0.001$) and women who achieved IPT5+ were found to be 98% less likely to have an adverse pregnancy outcome (AOR=0.02, CI=0.01-0.08, $p<0.001$) compared to women who took less than three doses of IPT ($p<0.001$).

Table 9: Logistic regression model of the association between number of IPTp doses taken and adverse pregnancy outcomes among study participants

	Adverse pregnancy outcome n/N (%)	Unadjusted model		Adjusted model	
		cOR [95% CI]	P-value	aOR [95% CI]	P-value
Number of IPTp dose					
Inadequate dose (<3 dose)	39/58 (67.2)	1.00 [reference]		1.00 [reference]	
Sub-optimal dose (3-4 dose)	28/220 (12.7)	0.07 [0.04, 0.14]	<0.001	0.04 [0.01, 0.10]	<0.001
Optimal dose (5+ doses)	5/107 (4.7)	0.02 [0.01, 0.07]	<0.001	0.02 [0.01, 0.08]	<0.001

cOR: crude odds ratio. aOR: adjusted odds ratio. CI: confidence interval

Variables controlled for in the adjusted model included: Number of ANC visits, awareness that pregnant women were at greater risk of malaria, awareness that malaria in pregnancy can lead to negative pregnancy outcome, awareness that malaria can be transmitted to foetus, taking nothing to prevent malaria during pregnancy, taking antimalaria drugs to prevent malaria during pregnancy, using mosquito spray to prevent malaria during pregnancy, awareness of how much time should pass between SP doses, awareness of the recommended SP doses, awareness of any side effect of taking SP, experience of negative side effect after taking SP, awareness that sleeping under ITN can help prevent malaria, taking of SP doses either inside or outside facility, cost of transportation affect ANC attendance, and availability of transportation affecting ANC attendance.

4.6.3 Association between IPTp Uptake and Low Birthweight

Only 2.8% of the women who took at least five doses had low birthweight babies versus the 9.5% of women who took only 3-4 doses and the 55.2% of women who took less than three doses of IPTp-SP. Compared to women who took less than three doses of IPT, women who took 3-4 doses had 94% decreased odds of having a low birthweight baby (AOR=0.06, CI=0.02-0.17, $p<0.001$) and women who took at least 5 doses had 97% decreased odds of having a low birthweight baby (AOR=0.03, CI=0.01-0.12, $p<0.001$). A p-value of less than

0.001 for both IPT3-4 and IPT5+ indicates that this difference is statistically significant (Table 10).

Table 10: Logistic regression model of the association between number of IPTp doses taken and low birth weight among study participants

	Low birthweight n/N (%)	Unadjusted model		Adjusted model	
		cOR [95% CI]	P-value	aOR [95% CI]	P-value
Number of IPTp dose					
Inadequate dose (<3 dose)	32/58 (55.2)	1.00 [reference]		1.00 [reference]	
Sub-optimal dose (3-4 dose)	21/220 (9.5)	0.09 [0.04, 0.17]	<0.001	0.06 [0.02, 0.17]	<0.001
Optimal dose (5+ doses)	3/107 (2.8)	0.02 [0.01, 0.08]	<0.001	0.03 [0.01, 0.12]	<0.001

cOR: crude odds ratio. aOR: adjusted odds ratio. CI: confidence interval

Variables controlled for in the adjusted model included: Number of ANC visits, marital status, educational level, parity, awareness that pregnant women were at greater risk of malaria, awareness that malaria in pregnancy can lead to negative pregnancy outcome, awareness that malaria can be transmitted to foetus, taking nothing to prevent malaria during pregnancy, taking antimalaria drugs to prevent malaria during pregnancy, awareness of the recommended SP doses, awareness of any side effect of taking SP, experience of negative side effect after taking SP, awareness that sleeping under ITN can help prevent malaria, taking of SP doses either inside or outside facility, cost of transportation affecting ANC attendance, availability of transportation affecting ANC attendance and road network affecting ANC attendance.

4.6.4 Association between IPTp Uptake and Preterm Delivery

Using inadequate IPT dosage as the reference (<3 doses), a statistically significant association is shown between the number of IPT doses taken during pregnancy and the incidence of preterm birth in Table 11. Preterm birth accounted for 27.6% of pregnancy outcomes among those who received inadequate IPT doses, 5.0% for those who received 3-4 IPT doses, and 1.9% for those who received 5 or more IPT doses. Compared to those who took less than 3 doses, women who took 3-4 doses were 85% less likely to give birth preterm (AOR=0.15, CI=0.05-0.40, $p<0.001$), whereas women who took 5 or more doses (IPT5+) were found to be 96% less likely to experience preterm birth (AOR=0.04, CI=0.01-0.17, $p<0.001$).

Table 11: Logistic regression model of the association between number of IPTp doses taken and preterm birth among study participants

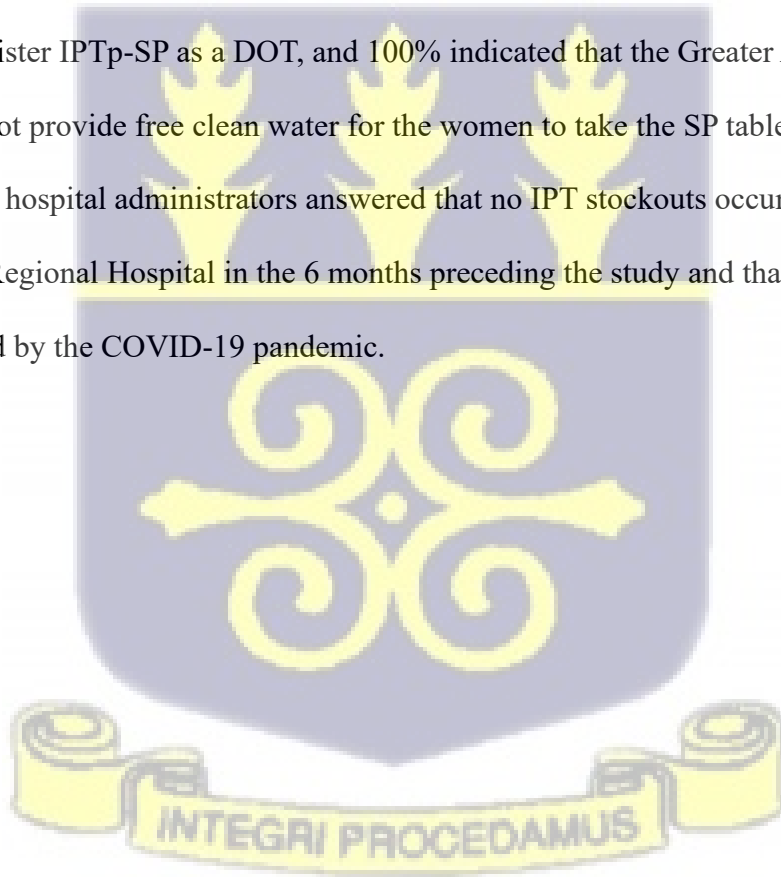
	Preterm birth n/N (%)	Unadjusted model		Adjusted model	
		cOR [95% CI]	P-value	aOR [95% CI]	P-value
Number of IPTp dose					
Inadequate dose (<3 dose)	16/58 (27.6)	1.00 [reference]		1.00 [reference]	
Sub-optimal dose (3-4 dose)	11/220 (5.0)	0.14 [0.06, 0.32]	<0.001	0.15 [0.05, 0.40]	<0.001
Optimal dose (5+ doses)	2/107 (1.9)	0.05 [0.01, 0.23]	<0.001	0.04 [0.01, 0.17]	<0.001

cOR: crude odds ratio. aOR: adjusted odds ratio. CI: confidence interval

Variables controlled for in the adjusted model included: Awareness that malaria in pregnancy can lead to negative pregnancy outcome, using mosquito spray to prevent malaria during pregnancy, awareness of the time to start taking SP doses, being diagnosed of malaria during pregnancy and cost of transportation affecting ANC attendance

4.7 Health Worker and Administrative Questionnaires

Ten health workers filled out the supplementary health worker questionnaire. Of these women, 30% answered that they had not received any training on IPTp-SP, 100% answered that they administer IPTp-SP as a DOT, and 100% indicated that the Greater Accra Regional Hospital does not provide free clean water for the women to take the SP tablets with. In addition to this, hospital administrators answered that no IPT stockouts occurred at the Greater Accra Regional Hospital in the 6 months preceding the study and that the SP stock was not affected by the COVID-19 pandemic.



CHAPTER 5: DISCUSSION

5.1 Proportion of Women that Received at Least Three doses of SP

The proportion of pregnant women in this study who received at least three doses of IPT is 84.9% (IPT3+). This proportion is greater than the 61% of women in Ghana who received IPT3+ in 2019 as shown by the 2019 MIS, which suggests that IPT3+ uptake at the Greater Accra Regional Hospital is higher than the national average. This finding is also similar to the findings of an earlier study carried out at a maternity home in the Osu Klottey sub-district of Accra, which found that 87.5% of study participants received three or more doses of IPT (Owusu-Boeteng, 2017). The high percentages of women who received IPT3+ in each of these respective studies, and the increased uptake seen in this study compared to the 2019 MIS, indicates that current IPTp-SP recommendations are effective in promoting IPT3+ utilization.

5.2 Proportion of Women that Received Five or More Doses of SP

While a large proportion of participants in this study received three or more doses of IPT, a much smaller proportion of them actually achieved five or more doses of IPT (IPT5+). In fact, only 27.8% of the women who participated in this study received 5 or more doses of IPT while pregnant. It is unknown if this is similar to national level data because the Ghana MIS does not report IPT5+ uptake. In 2017, Ghana's NMCP changed their policy on IPTp-SP to reflect the WHO's recommendation of three or more doses instead of their previous recommendation to attain only up to IPT3. The findings of this study suggest that while this policy is effective at promoting IPT3+, it fails to promote the uptake of IPT5 or more. This is evidenced by the fact that only 107 of the 327 women who attained IPT3+ actually received five or more doses of IPT5. A similar finding can be seen in the Owusu-Boateng study, which found the proportion of IPT5 to be significantly lower than the proportion of IPT3 (14.5% versus 87.5%).

5.3 Proportion of Women that Received Less than Three Doses of SP

Out of 385 total participants, 15.1% failed to receive at least three doses of IPT during their pregnancies. Stock levels at the Greater Accra Regional Hospital were assessed and found not to have contributed to the inadequate IPT uptake of the 58 women who received less than three doses. According to hospital administrators who answered the questions posed by the Administrative Questionnaire in Appendix IV, no SP stockouts occurred in the six months leading up to the study and the COVID-19 pandemic did not affect SP stock at the facility. Multiple other studies on IPTp-SP, however, have identified SP stockouts as a common barrier to the utilization of IPT3+ (Owusu-Boateng, 2017; Ameh et al., 2016). Since this was not the case at the Greater Accra Regional Hospital, it is likely that other factors are to blame for the 15.1% of women who did not achieve IPT3+, including lack of knowledge of IPTp-SP among women at the Greater Accra Regional Hospital.

5.4 Association Between the Number of Doses of SP and Specific Pregnancy Outcomes.

The results of this study, as shown in Tables 8-11, show that increased IPTp doses, specifically IPT3+ and even more so IPT5+, are associated with a decreased likelihood of adverse pregnancy outcomes, specifically low birthweight and preterm delivery. Compared to those who received less than three doses of IPT, women who received five or more doses were 97% less likely to have a low birthweight baby while women with at least three doses were 94% less likely. A similar trend was seen between IPT uptake and preterm delivery: women with IPT5+ were 96% less likely to give birth preterm and women with IPT3+ were 85% less likely. An inverse relationship between IPT dosage and the risk of low birthweight has been demonstrated by numerous other studies, including one that found a 22% reduction in the risk of low birthweight among women who took IPT compared to women who did not, and another that identified an 83% reduction in the risk of low birthweight among women with IPT3+ compared to women who did not take any IPT (Desai et al., 2016; Mikomangwa

et al., 2019). A systematic review of more than 6000 pregnancies also concluded that increased IPTp-SP uptake, specifically IPT3+, was associated with fewer instances of low birthweight (Kayentao et al., 2013). While there is an obvious association between IPTp-SP utilization and low birthweight, other studies have found the association between IPTp uptake and preterm delivery to be less pronounced (Roh et al., 2020). Though this study failed to find a significant association between IPTp uptake and stillbirth, a separate study found that taking three or more doses of IPT reduced stillbirth deliveries by more than 20% (Kamau et al., 2023).

5.5 Proportion of Preterm Delivery, Low Birthweight, and Stillbirth

Of the 385 women who participated in this study, nearly 20% experienced adverse pregnancy outcomes. The prevalence of low birthweight in this study, 14.5%, is similar to the global prevalence of low birthweight, which has been cited by WHO as 15.5% (Mahumud et al., 2017). Similarly, the prevalence of preterm delivery in this study was found to be similar to the prevalence of preterm delivery globally. Recent data from the World Health Organization shows that approximately 10% of babies are born preterm, which is comparable to the 7.5% of babies born preterm in this study (WHO, 2023). Since only one stillbirth was recorded in this study, it is difficult to make any meaningful comparisons to global level data. However, the prevalence of stillbirths in this study, 0.3%, is lower than the 1.7% of stillbirths recorded at over 650,000 deliveries in Ghana in 2017 (Vanotoo et al., 2023).

5.6 Factors associated with the uptake of IPTp-SP

The sociodemographic factors that were found to be significantly associated with IPTp uptake among women at the Greater Accra Regional Hospital include marital status, trimester at first ANC visit (first trimester, second trimester, or third trimester), and number of ANC visits attended (<4, 4-7, 8+). A greater number of women whose first ANC appointment occurred during the first trimester (29.6%) were able to achieve optimal IPTp uptake

compared to the number of those who started ANC in the second trimester (27.0%) – and none of the women who began ANC during their third trimester were able to so. Similarly, 34.6% of women who attended 8+ ANC appointments received optimal IPTp uptake, while only 7.9% of the women who attended 4-7 times and none of the women who attended less than 4 times were able to so (Table 3). The number of ANC visits attended was also found to be associated with IPT3+ uptake, with data showing that women with 8+ ANC visits had significantly increased odds of receiving at least three doses of IPT than those who attended ANC less than 8 times. These findings suggest that greater ANC attendance and early initiation of ANC are key determinants of increased IPTp uptake and support the WHO's recommendations for women to initiate contact with ANC during the first trimester and to attend ANC at least 8 times before delivery (WHO, 2016b). Therefore, it is crucial that health workers encourage women to begin ANC early in the pregnancy and attend ANC throughout the pregnancy in order to optimize IPTp-SP utilization. Though this study failed to produce a significant association between education level and IPT uptake, other studies in sub-Saharan Africa have found education level to be a very important factor in predicting IPT uptake. In fact, one such study found that women who attended senior high school or tertiary school are 2 times more likely to take three doses of IPT (Exavery et al., 2014).

Factors related to knowledge of malaria and malaria prevention practices, including IPTp-SP, were also found to be significantly associated with IPTp uptake. More than 70% of those who took five or more doses of IPTp knew malaria in pregnancy can lead to negative pregnancy outcomes such as low birthweight, preterm delivery, and stillbirth – a sharp contrast compared to the less than 50% of those who received inadequate or no IPT.

Knowledge of what IPT stands for and when it should be initiated was also highest among those who took IPT5. A 2018 study carried out in Mozambique found that poor knowledge of IPTp-SP was significantly associated with inadequate IPT uptake (AOR=1.6, $p<0.001$)

(Arnaldo et al., 2018). This, along with the findings of this study, indicate that having knowledge of malaria and malaria prevention strategies is associated with increased IPTp uptake. Additionally, it is clear from Table 5 that many of the women who failed to receive three doses of IPT had concerns regarding transportation and time availability. To combat these issues and promote optimal IPTp uptake in Ghana, future interventions should focus on improving the road network, minimizing the wait time at ANC clinics, and educating women on the importance of IPTp-SP and the dangers of malaria in pregnancy. Reducing the wait time at ANC appointments may also help ensure that more women take SP inside of the health facility, though other studies show that the provision of free water (which is not provided to patients at the Greater Accra Regional Hospital) may also be an effective means of achieving this (Doku et al., 2016).

The results in Table 6 show that there was a 4% decrease in IPT3+ uptake among those who experienced side effects (AOR=0.96, CI=0.36-2.58), but this was not significant – meaning that the experience of negative side effects after taking the drug did not deter women at the Greater Accra Regional Hospital from achieving IPT3+. One possible explanation for this is that the reported side effects may not have occurred until after the third dose of IPT and thus women were not deterred from taking the first three doses. Alternatively, this finding may indicate that the women who experienced negative side effects also recognized the important role that IPTp-SP plays in preventing the adverse effects that malaria can have on pregnancy and thus they continued to take IPT until they reached the minimum recommendation, IPT3, despite the side effects associated with the drug. Interestingly enough, the data in Table 7 tells a different story – that women who experienced negative side effects were actually 2.15 times more likely to take IPT5+ than women who did not experience side effects when taking the drug ($p=0.024$). This should not be interpreted to mean that the experience of negative side effects promotes the uptake of IPT; in fact,

according to Akinleye et al., a common barrier to ITP uptake is actually the unwillingness of women to take the drug due to their concern of negative side effects (Akinleye et al., 2009). Instead, this data may be a reflection of the fact that women who take more IPT doses are simply more likely to have a bad experience with the drug because they took it more times, e.g., a woman who takes IPT5 has two more opportunities to experience a negative side effect than a woman with IPT3. What the data regarding side effects in both Tables 5 and 6 have in common, however, is that they indicate that the experience of negative side effects does not serve as a deterrent to IPT3+ or IPT5+ uptake. A 2012 study conducted among women in Nigeria arrived at a similar conclusion and suggests that side effects won't deter women from increased IPT uptake as long as the SP is recommended and provided to them by a health worker, for it is unlikely that health workers would recommend taking the drug if it posed any risk of serious harm (Onoka et al., 2012).

Also worth noting are the findings regarding IPT5+ and ITN usage in Table 7, which shows that women who slept under ITNs during their pregnancies were actually 50% less likely to achieve optimal IPT uptake, IPT5+ (AOR=0.50, CI=0.30-0.84). A possible explanation for this is that perhaps women who sleep under ITNs and have already taken the minimum recommended dosage, IPT3, feel as though they are protected enough already or are satisfied with the protection provided by IPT3 and ITN usage, thus negating the need for them to seek the additional doses of IPT necessary for achieving optimal uptake.

Additionally, a strong bivariate association was found between IPT5+ uptake and having the knowledge that sleeping under an ITN can help prevent malaria during pregnancy, with 95.3% of women with IPT5+ saying that they were aware of this (Table 4). Interestingly enough, however, Table 4 also shows that only 57.0% of the women who took IPT5+ actually slept under an ITN during their most recent pregnancy. The 2019 Ghana MIS, which found a similar gap between IPT access and IPT usage among Ghanaian households (67% vs 43%),

suggests that low ITN utilization is due to the fact that some households prefer alternative mosquito protection methods and sleeping under ITNs is uncomfortable in Ghana's warm temperatures. MIS data also shows that utilization of ITNs is lowest in the Greater Accra Region (only 19% of households), which supports the finding that only 57% of women with IPT5+ reported sleeping under ITNs while pregnant.

5.7 Limitations

For the patient questionnaires to be completed, some information needed to be taken from the participants' ANC books (e.g., IPT uptake, pregnancy outcome, ANC visits, etc.). For postnatal mothers whose babies were in the NICU, the PI and research assistants were unable to access ANC books as they were in the NICU rather than with the mothers in the postnatal unit and CWC. Because of the many complications associated with low birthweight and preterm babies, it is likely that many of them were in the NICU. However, these cases could not be included in the study because the PI and research assistants did not have access to the NICU at the Greater Accra Regional Hospital, which means that sampling bias may have occurred as a result. Additionally, some women who were approached to participate in the study did not have their IPTp-SP uptake recorded in their ANC books, which meant that there was no way for the PI or research assistants to verify how many doses of IPT they took and therefore these women could not be included in the study. The likely reason that their IPTp-SP doses were not documented in their books is because the books were not given to them until they gave birth – so it is likely that these women didn't attend ANC and thus didn't receive IPT. Because this could not be verified by their books, however, these women could not participate in the study and sampling bias likely occurred as a result. Lastly, many study participants were recruited from CWC while bringing their babies in for growth monitoring and immunizations. This is important to note because women who experienced stillbirth did

not require child welfare services and thus were not likely to be found in this area of the hospital.



CHAPTER 6: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The findings of this study revealed the proportion of IPTp uptake at the Greater Accra Regional Hospital. It was found that 4.4% of the women did not take any doses of IPT, 4.2% received only 1 dose of IPT, 6.5% received exactly 2 doses of IPT, 33.5% received exactly 3 doses of IPT, 23.6% received exactly 4 doses of IPT, 27.0% received exactly five doses of IPT, and 0.8% received 6 or more doses of IPT. Proportions of IPTp-SP uptake among study participants were determined to be 15.1% inadequate uptake (<3 doses), 84.9% adequate uptake (IPT3+), 72.2% sub-optimal uptake (IPT3-4), and 27.8% optimal uptake (IPT5+).

Knowledge of malaria and malaria prevention practices, as well as greater ANC attendance and early initiation of ANC, were found to be significantly associated with increased IPTp uptake. Both IPT3+ and IPT5+ were associated with a reduced likelihood of adverse pregnancy outcomes, specifically low birthweight and preterm delivery. While the findings show that IPT3+ and IPT5+ are more effective compared to anything less than IPT3, they also suggest that women who take IPT5+ were the least likely of all to experience low birthweight and preterm delivery.

6.2 Recommendations

The official guidelines for IPTp-SP administration set forth by the World Health Organization state that women in malaria-endemic areas should receive at least three doses of SP, beginning as early as possible after the first trimester of pregnancy (typically around 16 weeks). This policy does not definitively state a maximum number of IPTp doses that can be taken, but instead encourages women to continue receiving IPTp-SP every month until delivery. The findings of this study support that the attainment of IPT3+ is extremely effective compared to anything less. However, the findings of this study also indicate that IPT5+ effectively reduces the odds of adverse pregnancy outcomes, including low

birthweight and preterm delivery, to an even greater degree than IPT3+. For this reason, the Greater Accra Regional Hospital and other health facilities located in malaria-endemic areas should promote the uptake of IPT5 as opposed to primarily promoting the uptake of IPT3+.

Should future scaled-up studies confirm that IPT5+ is more effective at preventing adverse pregnancy outcomes than IPT3, the WHO and Ghana's National Malaria Control Program should consider revising their current recommendation for IPTp-SP from at least three doses to at least five doses. By doing so, perhaps Ghana and the rest of the WHO African Region will be able to achieve significant reduction in malaria mortality and a decrease in the number of neonatal deaths that occur as a result of low birthweight and preterm birth.



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APPENDIX I: PARTICIPANT INFORMATION SHEET

Title: Uptake of Intermittent Preventive Treatment of Malaria with Sulfadoxine-Pyrimethamine and Pregnancy Outcomes in the Greater Accra Regional Hospital in Accra, Ghana

Principal Investigator: Emily Saathoff

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General Overview of Research

Malaria is a major public health concern worldwide and poses a significant threat to women who are pregnant in malaria endemic countries such as Ghana. Intermittent preventive treatment with sulfadoxine pyrimethamine (IPTp-SP) plays a crucial role in preventing adverse pregnancy outcomes due to malaria infection during pregnancy. This study aims to assess the association between IPTp-SP uptake, which ranges from IPT1 to IPT5, with pregnancy outcomes, specifically preterm birth, low birthweight, and stillbirth, at the Greater Accra Regional Hospital. An additional objective of this study is to identify factors associated with low and high uptake of IPTp-SP, including sociodemographic, knowledge, and health system characteristics.

Nature of Study

Using a cross-sectional study design, the study will use a minimum sample size of 385 women from the Greater Accra Regional Hospital who have given birth in the last six months. Participants who participate in the study will be required to give signed consent prior to participation. Information will be collected by the Principal Investigator and Research Assistant(s) from participants' hospital records and ANC books. In addition to this, participants will be asked to fill out a structured questionnaire regarding sociodemographic, knowledge,

and health system factors that may be associated with their IPTp-SP uptake. The time required to obtain information and fill out the questionnaire should not exceed 30 minutes.

Potential Risks

COVID-19 protocols will be observed by the Principal Investigator and Research Assistant(s) to minimize exposure to participants, and participants are expected to observe COVID-19 safety protocols as well. There is minimal risk associated with participation in this study.

Benefits of Study

Data collected from the study will not directly benefit study participants, but may be used by public health officials in the future to improve IPTp-SP implementation in facilities throughout Ghana. Any improvements have the potential to reduce adverse pregnancy outcomes associated with malaria in pregnancy.

Confidentiality

Participant information and data collected by researchers will only be accessible to the Principal Investigator, Research Assistants, and Supervisor. All efforts will be made to ensure confidentiality and identities of participants will not be recorded. The Ghana Health Service Ethics Review Committee may access the information collected from the study, but the identities of the participants will not be disclosed.

Cost

Participants in the study will not incur any costs as a result of their participation.

Compensation

Participants will not be compensated for their participation in the study.

Voluntary Participation and Withdrawal

Participation in this study is completely voluntary. All participants reserve the right to withdraw from the study at any time should they not wish to participate further.

Outcome and Feedback

The findings of this study will be shared with the Medical Director of the Greater Accra Regional Hospital and the Greater Accra Regional Health Directorate of the Ghana Ministry of Health.

Participant Feedback

Should any participant indicate a desire to view the study outcomes, feedback will be provided upon completion of research.

Funding Information

The Principal Investigator is solely responsible for the funding of this study.

Sharing of Participant Information/Data

The identities of those who participate in the study will not be recorded, thus data collected during the study will be anonymous.

Data Access and Storage

The Principal Investigator will securely store all completed questionnaires. Password protection will be used to ensure that access to computerized data is limited to only the Principal Investigator.

Provision of Information and Consent for Participants

All participants will receive a copy of the Information Sheet and Consent Form once they've been signed.

Further Questions or Clarification

Participants can contact the Principal Investigator, Emily Saathoff, for all questions or issues related to the study. For ethical issues, the Ghana Health Service Ethics Review Committee (GHS-ERC) administrator, Nana Abena Apatu, can be reached during working hours via phone (0503539896) or email (ethics.research@ghs.gov.gh).

APPENDIX II: CONSENT FORM

STUDY TITLE: Uptake of Intermittent Preventive Treatment of Malaria with Sulfadoxine-Pyrimethamine and Pregnancy Outcomes in the Greater Accra Regional Hospital in Accra, Ghana

PARTICIPANTS' STATEMENT

I acknowledge that I have read or have had the purpose and contents of the Participants' Information Sheet read and all questions satisfactorily explained to me in a language I understand, **English or Twi**. I fully understand the contents and any potential implications as well as my right to change my mind (i.e. withdraw from the research) even after I have signed this form.

I voluntarily agree to be part of this research.

Name of Participant.....

Participants' Signature OR Thumb Print.....

Date:.....

INTERPRETERS' STATEMENT

I interpreted the purpose and contents of the Participants' Information Sheet to the afore named participant to the best of my ability in the **Twi language** to his proper understanding.

All questions, appropriate clarifications sort by the participant and answers were also duly interpreted to his/her satisfaction.

Name of Interpreter.....

Signature of Interpreter..... OR Thumb Print

Date:.....

Contact Details

STATEMENT OF WITNESS

I was present when the purpose and contents of the Participant Information Sheet was read and explained satisfactorily to the participant in the language he/she understood, **English or Twi**.

I confirm that he/she was given the opportunity to ask questions/seek clarifications and same were duly answered to his/her satisfaction before voluntarily agreeing to be part of the research.

Name:.....

Signature..... OR Thumb Print

Date:.....

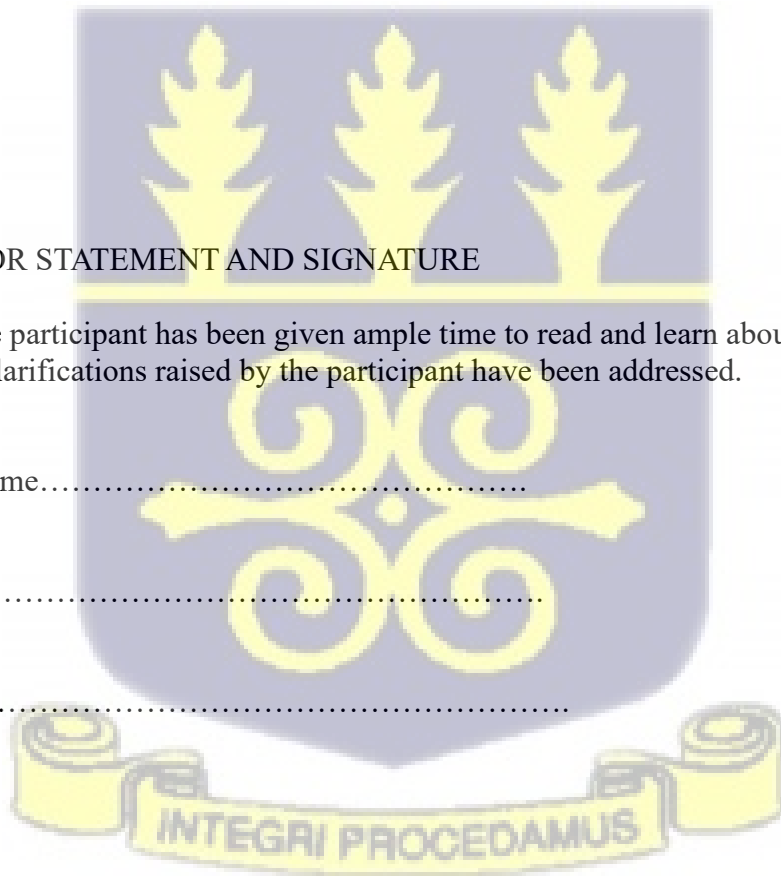
INVESTIGATOR STATEMENT AND SIGNATURE

I certify that the participant has been given ample time to read and learn about the study. All questions and clarifications raised by the participant have been addressed.

Researcher's name.....

Signature

Date.....



APPENDIX III: PATIENT QUESTIONNAIRE

Research Title: Uptake of Intermittent Preventive Treatment of Malaria with Sulfadoxine-Pyrimethamine and Pregnancy Outcomes in the Greater Accra Regional Hospital in Accra, Ghana

Date: _____

IPTp-SP Uptake:

- ☐ No IPT ☐ IPT1 ☐ IPT2 ☐ IPT3
☐ IPT4 ☐ IPT5 ☐ IPT6+

Week of Pregnancy at first dose: _____

Pregnancy Outcome:

- ☐ At-term birth ☐ Preterm Delivery ☐ Low Birthweight
☐ Stillbirth

If other complication, please state here: _____

Date of First ANC Visit: _____

Trimester at First ANC Visit:

- ☐ First Trimester ☐ Second Trimester ☐ Third Trimester

Number of ANC Visits:

- ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9+ ☐

Section A: Sociodemographic Characteristics

Age:

☐ 18-19

☐ 20-29

☐ 30-39

☐ 40-49

Marital Status:

☐ Single

☐ Married

☐ Divorced

☐ Widowed

Place of Birth (Region):

☐ Greater Accra

☐ Ahafo

☐ Ashanti

☐ Bono East

☐ Brong-Ahafo

☐ Central

☐ Eastern

☐ Northern

☐ North East

☐ Oti

☐ Savannah

☐ Upper East

☐ Upper West

☐ Western

☐ Western North

☐ Volta

☐ Other country

Education Level (Highest Level Achieved):

☐ None

☐ Primary School

☐ Junior High School

☐ Senior High School

☐ Tertiary

Employment Status:

☐ Employed

☐ Unemployed

Religion:

☐ Christian

☐ Muslim

☐ Traditional

☐ Other

Parity (number of births):

☐ 1

☐ 2

☐ 3

☐ 4

☐ 5

☐ 6

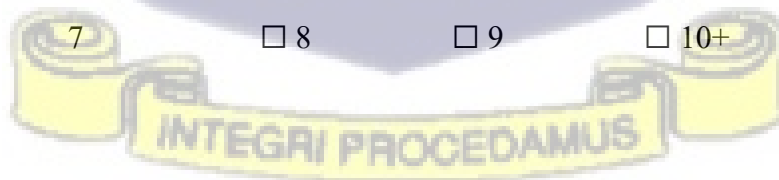
☐

7

☐ 8

☐ 9

☐ 10+



Section B: Knowledge Characteristics

Malaria Risk Factors:

Did you know that pregnant women are at greater risk of contracting severe malaria?

☐ Yes

☐ No

Did you know that malaria in pregnancy can lead to negative pregnancy outcomes, including preterm delivery, low birthweight, and stillbirth?

☐ Yes

☐ No

Did you know that malaria can be transmitted to the fetus during pregnancy?

☐ Yes

☐ No

Malaria Prevention:

What did you do to prevent malaria during your most recent pregnancy?

Do you know what IPTp stands for?

☐ Yes

☐ No

Do you know what time is recommended for pregnant women to start taking SP?

☐ Yes

☐ No

Do you know how much time should pass between SP doses?

☐ Yes

☐ No

How many doses of SP are recommended during pregnancy?

☐ I don't know

☐ IPT1

☐ IPT2

☐ IPT3

☐ IPT4

☐ IPT5

Do you know of any side effects associated with taking IPT-SP?

☐ Yes

☐ No

Have you ever experienced negative side effects after taking SP?

☐ Yes

☐ No

☐ N/A

Did you sleep under an insecticide treated net during your most recent pregnancy?

☐ Yes

☐ No

Did you know that sleeping under an insecticide treated net (ITN) can help prevent malaria during pregnancy?

☐ Yes

☐ No

Malaria Treatment:

Were you ever diagnosed with malaria during your most recent pregnancy?

☐ Yes

☐ No

Section C: Health System Characteristics

Insurance:

Are you registered under the National Health Insurance Scheme?

☐ Yes

☐ No

Sulfadoxine-Pyrimethamine (SP) Availability and Administration:

Was SP (the medication for IPTp) available at each ANC visit when needed?

☐ Yes

☐ No

☐ N/A

Did you take the SP tablets under the supervision of a health worker (DOT)?

☐ Yes

☐ No

☐ N/A

How did you obtain water to take the SP tablets?

☐ The facility provided it

☐ I brought it with me

☐ I had to go buy water

☐ N/A

Did you take the SP tablets inside or outside of the health facility?

☐ Inside

☐ Outside

☐ N/A

Accessibility:

For the following statements, select the answer that best reflects your opinion.

The cost of transportation made it difficult for me to attend ANC appointments.

☐ Agree

☐ Neutral

☐ Disagree

It is difficult for me to find transportation to the health facility for ANC appointments.

☐ Agree

☐ Neutral

☐ Disagree

The road network (traffic) made it difficult for me to attend ANC appointments.

☐ Agree

☐ Neutral

☐ Disagree

I feel that ANC services are too expensive.

☐ Agree

☐ Neutral

☐ Disagree

During my last pregnancy, the wait time to receive ANC was too long.

☐ Agree

☐ Neutral

☐ Disagree

The COVID-19 pandemic made it more difficult to attend ANC appointments or access ANC.

☐ Agree

☐ Neutral

☐ Disagree

Thank you for your participation in this study.



APPENDIX IV: ADMINISTRATIVE QUESTIONNAIRE

Research Title: Uptake of Intermittent Preventive Treatment of Malaria with Sulfadoxine-Pyrimethamine and Pregnancy Outcomes in the Greater Accra Regional Hospital in Accra, Ghana

Date: _____

SP Availability

Has the Greater Accra Regional Hospital experienced any SP stockouts in the last six months?

☐ Yes

☐ No

If yes, please state the period it occurred:

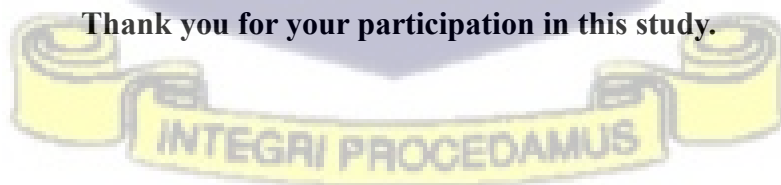
Has the stock of SP at the Greater Accra Regional Hospital been affected by the COVID-19 pandemic?

☐ Yes

☐ No

If yes, please state how:

Thank you for your participation in this study.



APPENDIX V: HEALTH WORKER QUESTIONNAIRE

Research Title: Uptake of Intermittent Preventive Treatment of Malaria with Sulfadoxine-Pyrimethamine and Pregnancy Outcomes in the Greater Accra Regional Hospital in Accra, Ghana

Date: _____

SP Administration

Have you received any training on IPTp-SP?

☐ Yes

☐ No

Do you provide SP to pregnant women as a directly observed therapy (DOT)?

☐ Yes

☐ No

☐ Sometimes

Are pregnant women provided with free clean water to take the SP tablets with?

☐ Yes

☐ No

Thank you for your participation in this study.

