WOLKITE UNIVERSITY

COLLAGE OF MEDICINE AND HEALTH SCIENCE DEPARTMENT OF PEDIATRICS AND CHILD HEATH

CLINICAL OUTCOME OF COMPLICATED MALARIA AND ASSOCIATED FACTORS AMONG CHILDREN LESS THAN 5 YEARS DIAGNOSED WITH MALARIA AT WOLKITE UNIVERSITY COMPREHENSIVE SPECIALISED TEACHING AND REFERRAL HOSPITAL A RETROSPECTIVE STUDY.

A THESIS SUBMITTED TO DEPARTMENT OF PEDIATRICS AND CHILD HEALTH,COLLAGE OF MEDICINE HEALTH SCIENCES,WOLKITE UNIVERSITY IN PARTIAL FULFILMENT OF REQUIRMENTS FOR SPECIALITY IN PEDIATRICS AND CHILD HEALTH TRAINING

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Feb, 2026

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A Thesis submitted to department of pediatrics and child health, collage of medicine and health sciences, Wolkite University in partial fulfilment of requirements for specialty in pediatrics and child health training.

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Full title of the research project	clinical outcome of sever malaria and associated factors among children less than 5 years diagnosed with malaria at Wolkite university comprehensive specialized teaching and referral hospital retrospective study.
Duration of project	Five months
Study area	Wolkite university teaching and referral Hospital
Total cost of the project	25,000ETB
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Feb 2026

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Approval sheet

As research Thesis advisor, I hereby certify that I have read and evaluated this thesis prepared, under guidance, by Abdulfetah Nuredin (final year pediatrics resident) titled, clinical outcome of sever malaria and associated factors among children less than 5 years diagnosed with malaria at Wolkite university comprehensive specialized teaching and referral hospital a retrospective study. We recommended that the Thesis shall be submitted as fulfilling requirement for the award of certificate of specialty in pediatrics.

Teklemichael Gebru _____ 17/2/2026

Dr. Numeri Hussen _____ 17/2/2026

As member of the board examiner for a specialty certificate in pediatrics Thesis open defense examinations, we certify that we have read, evaluated the Thesis prepared by, Dr.Abdulfetah Nuredin and examined the candidate. We recommended that the Thesis accepted as fulfilling the proposal for partial fulfillment of the requirement for a specialty certificate in pediatrics.

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Declaration

By my signature below, I declare and affirm that this thesis is my own work. I have followed all ethical principles of scholarship in the preparation, data collection, data analysis and completion of this Thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Every serious effort has been made to avoid any plagiarism in the preparation of this thesis.

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Acknowledgment

First and foremost, I would like to extend my greatest gratitude to our Almighty creator. My deepest gratitude and heartfelt thanks goes to my advisors **Mr.Teklemichael (Assistant Professor. Epid.) Dr.Numeri (MD, Assistant Professor in Pediatrics and Child Health)** for their unreserved professional support, technical guidance and advises throughout the process of this thesis development without any reservation. Finally, I would like to acknowledge Wolkite University, CMHS for providing me this golden opportunity to carry out this thesis as part of research methodology training and Hospital Administrator and Staffs for their support.

Abbreviations and Acronyms

ASDRs…….Age standardized DALY rates

ASIRs……...Age standardized incidence rate

DALYs…….Disability adjusted life year

EC……..Ethiopian calendar

EPU…….Emergency pediatrics unit

HMIS……..Health management information system

ICU……... Intensive care unit

ITN…….Insecticide treated net

µL……...Microliter

MIS…….Malaria index survey

MMHG……...Millimeter mercury

NTD……Neglected tropical diseases

NGO……Non-governmental organization

MMOL/dl…….Milimole per deciliter

OPD……...Outpatient department

SDI……..Socio demographic index

SPSS…….Statistical package for social sciences

WHO ……..World health organization

WUCSTRH……Wolkite University Comprehensive specialized teaching and referral hospital

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Abstract

Background: Malaria is a major public health problem and a life-threatening parasitic infection, particularly among immunologically naive children who are highly vulnerable to severe complications.

Objective: This study aimed to determine the clinical outcomes and factors associated with severe malaria among children under five diagnosed at WUCSRH in a retrospective study.

Methods: An institution-based retrospective cross-sectional study was conducted by reviewing medical records and logbooks of children under five diagnosed with malaria. A total of 427 children were selected using systematic random sampling. Data were collected using a structured questionnaire, cleaned, coded, entered into SPSS, and analyzed using descriptive statistics and logistic regression. Results were presented in narrative form and tables. **Results:** Of the 427 children, 190 (44.5%) had severe malaria. The most frequent complications were severe anemia 114 (26.7%), seizures 40 (9.4%), prostration 20 (4.7%), cerebral malaria 10 (2.3%), acute kidney injury 4 (0.9%), and hypoglycemia 2 (0.5%). Treatment outcomes showed that 177 (41.9%) were discharged improved, 1 (0.2%) referred, 7 (1.6%) left against medical advice, and 3 (0.7%) died. Season of presentation, duration of illness, and patient residence were independently associated with severe malaria. Children presenting in spring had lower odds of severe malaria compared to summer (AOR = 0.23; 95% CI: 0.10–0.55). Delayed presentation of 2–7 days increased the risk of severe malaria (AOR = 44.62; 95% CI: 23.01–86.53; $p < 0.001$), while children living near the health facility had lower odds (AOR = 0.25; 95% CI: 0.11–0.57; $p = 0.001$).

Conclusion: Severe malaria remains a significant cause of morbidity and mortality in children under five. Early healthcare seeking, improved access to health facilities, and preventive measures are essential to reduce its burden and improve outcomes in endemic areas.

Chapter One

1.1. Introduction

Malaria is a parasitic infectious disease caused by protozoan parasites of the genus *Plasmodium* and is transmitted by mosquitoes. It is characterized by recurrent symptoms of chills, fever and generalized body pain. The five *Plasmodium* species of human malaria are: *P. falciparum, P. vivax, P. ovale, P. malariae* and *P. knowlesi (1)*. Plasmodium falciparum and vivax are the two most common etiologies in Ethiopia (1) *Plasmodium falciparum* is found worldwide, mainly in tropical and subtropical areas. It is the main species that causes severe, potentially fatal malaria (1). *Plasmodium vivax* is found mainly in Asia, Latin America, and in some parts of Africa (e.g. Ethiopia and Madagascar). Evidence shows that *P. vivax* can cause severe illness. *P. vivax* and *P. ovale*) have dormant liver stages (hypnozoites) which would be activated and invade the blood to cause clinical relapse several weeks, months or years after the infectious mosquito bite(1). *Plasmodium ovale* is found mostly in the countries of West Africa and the islands of the western Pacific. It is biologically and morphologically similar to *P. vivax*. It is rarely reported in Ethiopia (1). *Plasmodium malariae* is found worldwide. It causes a persistent chronic infection which may be lifelong. A small number of patients develop serious complications such as the nephrotic syndrome (1). Severe falciparum malaria: For epidemiological purposes, severe falciparum malaria is defined as one or more of the following, Occurring in the absence of an identified alternative cause and in the presence of *P. falciparum* asexual parasitaemia (1).

Globally in 2023, there were almost 263 million estimated malaria cases (between lower and upper bounds of 23 million and 294 million, respectively in 83 malaria endemic countries (including the territory of French Guiana) an increase of 11 million cases compared with 2022 and 597000 deaths(2). Between 2000 and 2019, the number of annual estimated malaria cases remained stable, varying between 227 million and 248 million across the 108 countries that were malaria endemic in 2000(2). Since 2020, the number of estimated malaria cases has steadily increased, and most of this increase occurred in countries in the WHO African Region (89.7%) and the WHO Eastern

Mediterranean Region (15.5%) (2). The main countries contributing to the increase in cases between 2022 and 2023 were Ethiopia (+4.5 million), Madagascar (+2.7 million), Pakistan (+1.6 million), Nigeria (+1.4 million) and the Democratic Republic of the Congo (+600 000) (2) In 2021, there were 169,052,260 cases of malaria among children under the age of 15 worldwide, with an incidence rate of 8402.78 per 100,000 individuals (3). The incidence rate increased by an average of 0.87% per year from 2015 to 2021(3). From 1990 to 2015, there was no significant change in the global incidence of malaria (3). In 2021, 469,881 children under the age of 15 died from malaria worldwide, with a mortality rate of 23.36 per 100,000 individuals (3). The overall estimated pooled prevalence of malaria among children in Ethiopia was 9.07%. Subgroup analysis based on malaria signs and symptoms showed that the pooled prevalence of malaria among asymptomatic and symptomatic children was 6.67% and 27.17% respectively. The findings revealed a high prevalence of malaria among children in Ethiopia. As a result, still there is a need of improving and rechecking the existing malaria prevention and control measures of the country (4). Significance of the study: To the hospital; to have objective data and use it as an input for community intervention. To zone health bureau; to discuss severity of the problem and to suggest more emphasis on prevention. Contributing to evidence; since there is no published study in this hospital, zonal level or national level on this topic and specific age this study will provide an input for further study.

1.2. Statement of the problem

Globally in 2023, there were almost 263 million estimated malaria cases (between lower and upper bounds of 23 million and 294 million, respectively) in 83 malaria endemic countries (including the territory of French Guiana) an increase of 11 million cases compared with 2022(2). Between 2000 and 2019, the number of annual estimated malaria cases remained stable, varying between 227 million and 248 million across the 108 countries that were malaria endemic in 2000(2). Since 2020, the number of estimated malaria cases has steadily increased, and most of this increase occurred in countries in the WHO African Region (89.7%) and the WHO Eastern Mediterranean Region (15.5%) (2). the main countries contributing to the increase in cases between 2022 and 2023 were Ethiopia (+4.5 million), Madagascar (+2.7

million), Pakistan (+1.6 million), Nigeria (+1.4 million) and the Democratic Republic of the Congo (+600 000) (2).

Malaria is a leading health problem in Ethiopia (1). Three quarters (75%) of the country's landmass is malaria endemic and about 52% of the total population is at risk of malaria infection (1). Malaria transmission in Ethiopia mainly occurs up to the 2000 meter (m) elevation but can also occasionally affect areas up to 2300m elevation(1). The levels of malaria risk and transmission intensity within these geographical ranges, however, show marked seasonal, inter-annual and spatial variability because of large differences in climate (temperature, rainfall and relative humidity(1).

In 2021, there were 169,052,260 malaria cases and 469,881 deaths among children under 15 worldwide, with an incidence rate of 8402.78 per 100,000 and a mortality rate of 23.36 per 100,000(3). From 1990 to 2021, the global incidence rate of malaria in children under 15 showed a slight increase of 0.87% annually from 2015 to 2021, while the mortality rate decreased by 0.69% per year from 1990 to 2015 but remained stable thereafter(3). Additionally, there was a notable increase in the number of deaths and mortality rate from malaria in 2020 and 2021 compared to 2019(3). In a study done in Ethiopia Twelve studies with 34,842 under-five children were included. The pooled prevalence of under-five malaria was 22.03% Lack of insecticide-treated mosquito net utilization poor knowledge of child caretakers towards malaria transmission, and living near mosquito breeding sites) were risk factors of under-five malaria(5). More than one in five children aged under five years were infected with malaria. This suggests the rate of under-five malaria is far off the 2030 national malaria elimination program of Ethiopia (5). A study done wolkite HC, from a 121,230 clinically malaria suspected patients, the overall prevalence of microscopically confirmed cases were 8.56% (6). *Plasmodium vivax* was the most predominant species accounted for 69.7% followed by *Plasmodium falciparum* 29.3% (6). Age group > 15 years old were more affected by malaria accounting 54% (6). And malaria cases regarding sex were proportional (51.1% of males and 48.3% of female) (6). Among the catchment areas, a higher number of malaria prevalence was recorded in the Wolkite town 66.2%.Higher malaria cases were shown in the season of Spring 29.8% while lower cases 20.4% were seen in the Winter season(6) Over all malaria prevalence, morbidity, and mortality is increasing globally especially in sub-Sahara Africa countries including Ethiopia and more affecting children especially under five year

old(in hospital mortality 8.5-27%).studies show rate of under 5 malaria is far off from national malaria elimination program by 2030.

There is no recent available study on magnitude, treatment outcome, common complications of sever malaria and associated factors in under 5 children in our hospital in the Gurage zone and in our country . And a study done at wolkite HC from 2015-2018 showed the trend is decreasing, p.vivax is the most common species, age >15 were the most affected (26). That is discrepancy from clinical observation. Considering all the above, this study will provide updated data to provide community preventive measures, policy making and management plan at hospital, zonal and national level.

1.3. Significance of the study

- To the hospital; to have objective data and use it as an input for community intervention and plan for in hospital management.
- To zone health bureau; to discuss severity of the problem and to suggest more emphasis on prevention.
- Contributing to evidence; since there is no published study in this hospital, zonal or national level on this specific topic this study will serve as an input for further study

1.4. Objectives

1.4.1. General objectives:

To determine magnitude, clinical outcome of complicated malaria and associated factors among children less than 5 years diagnosed with malaria at WUCSTRH from September 11, 2020-September 10, 2025.

1.4.2. Specific objectives:

- To determine magnitude of complicated malaria in children less than 5 years diagnosed with malaria at WUCSTRH from September 11, 2020 – September 10 2025.
- To determine treatment outcome of complicated malaria in children less than 5 years diagnosed with malaria at WUCSTRH from September 11, 2020 – September 10 2025.
- To determine associated factors of complicated malaria in children less than 5 years diagnosed with malaria at WUCSTRH from September 11, 2020 – September 10 2025.

1.6. Operational definitions

Treatment outcome: discharged improved, dead, referred, left against medical advice

Delayed presentation: Came after two or more days of symptom onset

Distance from the health facility: far if >10 Kilometer, near if <10km.

Visited: Came to hospital with a compliant of illness and evaluated

Chapter Two

Literature Review

2.1 Global burden

Malaria remains a major global public health problem, particularly in tropical and subtropical regions. In 2023, an estimated 263 million malaria cases were reported across 83 malaria-endemic countries, reflecting an increase compared to the previous year (2). Although the global number of cases remained relatively stable between 2000 and 2019, a steady rise has been observed since 2020. The majority of this increase has occurred in countries within the WHO African Region, with additional contributions from the WHO Eastern Mediterranean Region (2). Countries such as Ethiopia, Madagascar, Pakistan, Nigeria, and the Democratic Republic of the Congo have been identified as major contributors to the recent rise in malaria cases (2). Children under 15 years of age continue to bear a disproportionate share of the malaria burden globally. In 2021, millions of malaria cases and a substantial number of deaths were reported among children in this age group (3). Trends over the past three decades indicate that while malaria incidence showed periods of decline, particularly between 2000 and 2015, progress has slowed in recent years. Since 2015, incidence has remained relatively stable, with slight increases observed after 2020 (2,3). Mortality among children declined over earlier decades but has shown stagnation in more recent years, with a noticeable increase in deaths during 2020 and 2021 compared to 2019 (3). These patterns suggest that global malaria control efforts have faced challenges in sustaining earlier gains.

The burden of malaria is not evenly distributed across regions. Sub-Saharan Africa continues to experience the highest disease burden, while high-income regions report the lowest levels of morbidity and mortality (7). The impact is particularly severe in low Socio-Demographic Index (SDI) settings, where malaria accounts for the vast majority of malaria-related

disability and premature death among children under five years of age (7). In 2019, malaria and other neglected tropical diseases together accounted for millions of cases and a substantial number of disability-adjusted life years (DALYs) among children and adolescents aged 0–19 years worldwide (7). Although some regions such as Andean Latin America and South Asia have demonstrated significant reductions in disease burden over time, the overall global burden among children remains considerable. Overall, despite earlier progress in reducing malaria incidence and mortality, recent trends indicate stagnation and resurgence in several high-burden countries, particularly within Sub-Saharan Africa. Children remain the most vulnerable population group, highlighting the continued need for strengthened prevention, early diagnosis, and effective case management strategies in endemic regions (2, 3 and 7).

2.2. Africa burden of malaria

During the COVID-19 pandemic, disruptions in health service utilization were observed, including delayed presentation to health facilities. This delay was associated with increased severity at the time of diagnosis, with children more likely to present with multiple clinical features of severe malaria (8). These findings suggest that public health emergencies can indirectly worsen malaria outcomes by limiting timely access to diagnosis and treatment. Malaria continues to pose a substantial public health challenge in Sub-Saharan Africa (SSA), particularly among under-five (UN5) children who represent the most vulnerable group (9). Despite sustained global and regional control efforts, the burden of malaria in high-risk African countries remains high, contributing significantly to childhood morbidity and mortality (9). The persistence of malaria in these settings reflects the complex interaction of multiple determinants, including child-related factors, maternal characteristics, and household conditions. Understanding how these factors collectively influence malaria transmission and disease occurrence is essential for designing targeted and context-specific interventions (9).

Evidence from Malaria Indicator Surveys (MIS) conducted between 2010 and 2023 demonstrates that malaria prevalence among under-five children remains considerable, with notable variation across countries (9). These differences highlight the heterogeneity of

malaria epidemiology within the region and underscore the importance of localized control strategies. Similarly, a multi-country analysis using recent MIS data from 13 Sub-Saharan African countries reported a consistently high pooled prevalence of malaria among children aged 6–59 months (10). The findings emphasize that, despite progress in some settings, malaria transmission remains sustained in many SSA countries. Overall, the literature indicates that malaria among young children in Sub-Saharan Africa is influenced by a combination of healthcare access, socio-demographic characteristics, and household-level determinants. Continued surveillance, strengthened health systems, and targeted preventive measures remain critical to reducing the burden of malaria in this highly vulnerable population (8–10).

2.3. Ethiopia burden of malaria

Evidence from different parts of Ethiopia demonstrates variability in malaria magnitude, species distribution, and affected population groups. A study conducted in Gondar reported that most malaria patients were male and predominantly from rural areas, with a large proportion referred from other health facilities (11). The dominant parasite identified in that setting was *Plasmodium falciparum*, indicating its continued clinical significance in northern Ethiopia (11). In southern Ethiopia, the overall prevalence of malaria was relatively low; however, marked variation was observed across specific localities, with some areas reporting substantially higher transmission (27). *Plasmodium falciparum* was the predominant species, followed by *Plasmodium vivax*, and a notable proportion of mixed infections was also documented (27). Malaria affected both younger children and school-aged groups, suggesting ongoing community-level transmission (27). Similarly, in southwest Ethiopia, nearly one-quarter of examined children were found to have malaria infection (28). In that study, *Plasmodium falciparum* was the leading species, though *Plasmodium vivax* and mixed infections were also reported (28). The study further highlighted community awareness regarding malaria transmission, with most caregivers recognizing mosquito bites as the primary mode of transmission. Preventive strategies such as insecticide-treated nets (ITNs) were commonly mentioned, whereas indoor residual spraying (IRS) was less frequently identified (28). This suggests that while awareness exists, knowledge and utilization of comprehensive preventive measures may vary.

In Sidama region, malaria coexisted with anemia among children, and a considerable proportion of anemic children were also infected with malaria (29). This finding underscores the clinical and public health importance of malaria as a contributing factor to childhood anemia and its broader impact on child health (29). Data from Wolkite Health Center indicate fluctuating malaria trends over several years (25, 26). One study reported that both *Plasmodium falciparum* and *Plasmodium vivax* were responsible for infections, with *P. vivax* accounting for a larger proportion of cases in more recent years (25). Another trend analysis from the same area showed a similar predominance of *Plasmodium vivax* and identified adults over 15 years as more frequently affected, although cases were nearly proportional between males and females (26). Seasonal variation was also observed, with higher malaria cases recorded during spring and lower transmission during winter (26). Additionally, urban areas such as Wolkite town contributed a considerable share of reported cases, reflecting the persistence of malaria transmission even in semi-urban settings (26). Overall, these Ethiopian studies demonstrate that malaria epidemiology varies by region, season, age group, and parasite species. While *Plasmodium falciparum* remains a major cause of infection in many areas, *Plasmodium vivax* has emerged as a dominant species in some localities. The coexistence of malaria with conditions such as anemia, along with seasonal and geographic variations, highlights the need for context-specific prevention and control strategies across different regions of the country (11, 25–29).

2.4. Treatment outcome

Mortality among children hospitalized with severe malaria varies considerably across regions and is strongly influenced by the quality and accessibility of health care services. In high-burden African settings, in-hospital mortality remains substantial, with reported rates ranging widely between different facilities and countries (14–17). Most deaths occur within the first 24 hours of admission, underscoring the critical importance of early recognition and immediate management. Common life-threatening complications include severe anemia, cerebral malaria, and respiratory distress syndrome, all of which significantly contribute to poor outcomes (14, 15). Beyond the acute phase, children who survive severe malaria remain vulnerable. Evidence indicates a high risk of post-discharge complications, including recurrent severe malaria and repeated hospitalizations, with a large proportion of

readmissions attributed to malaria itself (18). Additionally, long-term sequelae such as neurological and behavioral impairments have been documented among survivors, highlighting the broader and lasting impact of severe malaria on child development (19). Although prompt diagnosis, effective antimalarial therapy, and appropriate supportive care can substantially reduce mortality in optimal clinical settings, real-world outcomes in many endemic areas remain less favorable (20). Delayed presentation, limited diagnostic capacity, shortages of essential supplies, and inconsistencies in quality of care contribute to higher case fatality rates.

In Ethiopia, one study reported a considerable proportion of deaths among children admitted with severe malaria (11). Clinical features such as impaired consciousness, repeated convulsions, jaundice, high parasite burden, and elevated creatinine levels were identified as important indicators of poor prognosis (11). These findings emphasize the need for careful clinical assessment and close monitoring of high-risk patients. The COVID-19 pandemic further exacerbated malaria-related mortality. During this period, higher death rates were observed compared to the pre-pandemic era (8). Delayed presentation to health facilities and increased severity at admission were reported, suggesting that disruptions in healthcare access and utilization negatively affected outcomes for children with severe malaria (8). Overall, these findings highlight that severe malaria remains a life-threatening condition, particularly when diagnosis and treatment are delayed or when health systems are strained (8, 11, 14–20).

2.5. Associated factors

Several studies conducted in Sub-Saharan Africa have identified important determinants of severe malaria among young children, particularly factors related to delayed treatment, access to health services, and household conditions. A study conducted in Kampala among children aged 6 months to 5 years found that children with severe malaria experienced a longer duration of illness before receiving antimalarial treatment compared to those with uncomplicated malaria (33). Delayed initiation of treatment was strongly associated with progression to severe disease. The study also suggested that recent antimalarial exposure appeared to have a protective effect. In addition, lack of protective measures against

mosquito bites, such as the use of household vector control methods, was linked to an increased likelihood of severe malaria (33). These findings highlight the importance of early treatment and consistent use of preventive strategies in reducing disease severity. Similarly, research from Zimbabwe identified multiple risk factors associated with severe malaria, particularly those related to healthcare access and living conditions (34). Children living far from health facilities, those with prolonged symptoms before seeking care, and those who experienced delays in receiving antimalarial medication were more likely to develop severe disease. The presence of comorbidities and substandard housing conditions, such as living in unfinished structures, were also associated with increased risk. Conversely, ownership of insecticide-treated nets (ITNs) and maternal caregiving were found to have protective effects (34). These findings emphasize the combined influence of geographic accessibility, socioeconomic factors, and caregiving practices.

In Uganda, delayed care-seeking behavior, especially more than 24 hours after fever onset, was consistently identified as a major determinant of severe malaria (35). Initial care sought from informal providers such as drug shops, rather than formal health facilities, was also associated with higher risk. Increasing distance from residence to the nearest health center further contributed to delayed treatment and disease progression (35). This underscores the critical role of timely and appropriate health service utilization in preventing severe outcomes. A study from Burkina Faso similarly reported that socioeconomic and environmental factors were strongly linked to severe malaria (36). Low parental education, poor socioeconomic status, rural residence, and proximity to stagnant water sources were associated with increased severity. Cultural practices such as managing fever at home before seeking professional care were also identified as contributing factors. Delayed treatment was again a key determinant of progression to severe disease (36). Overall, the literature consistently demonstrates that severe malaria in children is influenced by a combination of delayed healthcare-seeking behavior, limited physical access to health facilities, inadequate preventive measures, socioeconomic disadvantage, and environmental exposure. These findings reinforce the need for community-level health education, improved accessibility to timely treatment, strengthened vector control interventions, and targeted support for vulnerable households to reduce the burden of severe malaria in endemic settings (33–36).

2.6. Complications

Severe malaria among Ethiopian children is frequently characterized by life-threatening clinical complications, particularly among under-five children. Severe anemia is one of the most commonly reported complications, accounting for a substantial proportion of severe cases (22, 23). This highlights the significant hematologic impact of malaria in young children, who are already vulnerable to anemia due to nutritional and infectious causes. Neurological manifestations such as impaired consciousness and recurrent convulsions are also commonly documented features of severe malaria (11, 23). These signs often indicate cerebral involvement and are associated with increased risk of mortality and long-term neurological sequelae. Other serious clinical presentations include jaundice, respiratory distress, and hyperpyrexia, all of which reflect systemic involvement and disease severity (11, 13, and 22). Additional complications such as persistent vomiting and hypoglycemia are frequently observed and may further worsen clinical outcomes if not promptly managed (22, 23). Less common but clinically significant manifestations, including hemoglobinuria and confusion, have also been reported (22, 23). Laboratory indicators such as high parasite density and elevated creatinine levels are consistently identified as markers of poor prognosis, suggesting multi-organ involvement and increased risk of adverse outcomes (11). Overall, the spectrum of severe malaria in Ethiopian children demonstrates significant multisystem involvement, emphasizing the need for early recognition, comprehensive clinical assessment, and timely management to prevent fatal complications (11, 13, 22, and 23).

2.6 conceptual framework

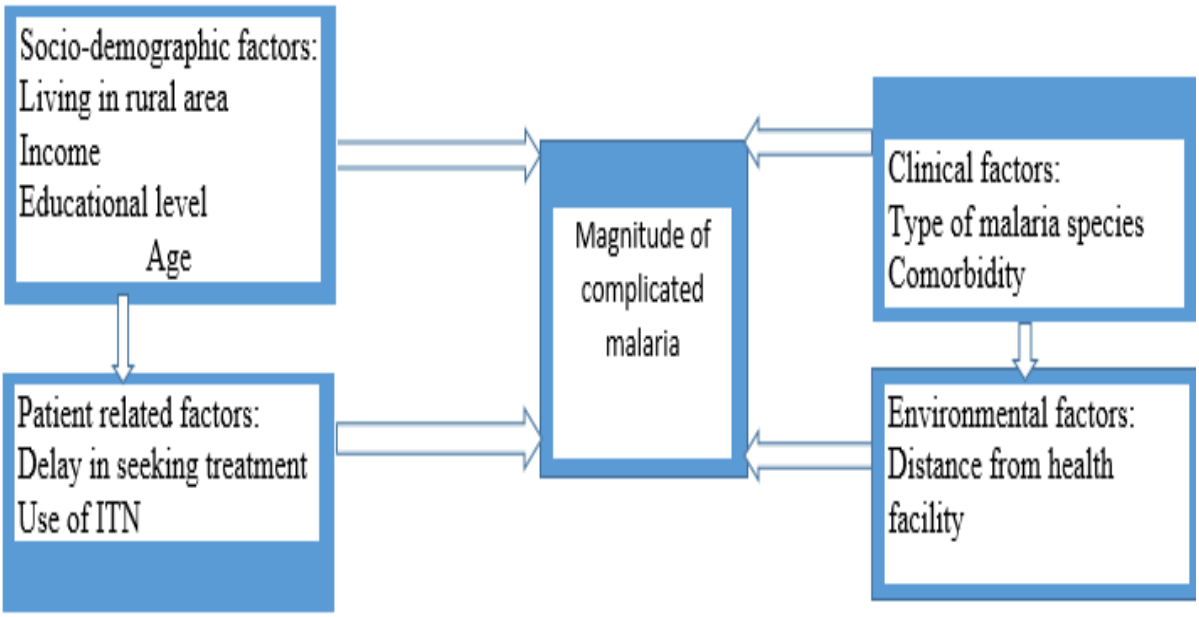

Figure 1 conceptual framework

Chapter Three

Methods and Material

3.1. Study design and period: Institution based retrospective cross sectional study design was used and the study period was from Nov to December 2026 GC.

3.2. Study area: Was Wolkite University comprehensive specialized teaching and referral hospital. It was established in July 2019 and serves as a referral center for Gurage zone and nearby regions for around 4 million people catchment areas. It is a comprehensive teaching and referral hospital affiliated with Wolkite University, College of health sciences with a total admission capacity of 300 beds for general major wards, orthopedics, ophthalmology, psychiatry units and general ICU having 6 beds. So far, the hospital has served for around 327,000 patients and sees around 70,000 patients per year pediatrics department is organized as pediatrics emergency, neonatal ICU, general pediatrics ward, OPD.(HMIS). Wolkite is the capital city of Gurage Zone that has an average annual temperature of 18.6 °C and an average rainfall of 1244 mm. The town has an elevation between 1910 and 1935 meters above sea level (29). Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia, Wolkite town has a total population of 28,856 of whom 15,068 were males and 13,788 females (30).

3.3. Source population and study population

3.3.1. Source population: Was all less than 5 year old patients who were diagnosed with malaria at WUCSTRH from September 11, 2020 – September 10, 2025 GC.

3.3.2 Study population: Was all less than 5 year patients diagnosed with malaria and fulfill inclusion criteria at WUCSTRH from September 11, 2020 – September 10, 2025 GC.

3.4. Inclusion and exclusion criteria

3.4.1 Inclusion criteria: all children age less than 5 yrs. with laboratory confirmed malaria from September 11, 2020 – September 10, 2025 GC. Was included.

3.4.2. Exclusion criteria: those laboratory negative and clinically treated for malaria were excluded and those with incomplete data were also excluded.

3.5. Sample size and sampling procedure

3.5.1.Sample size: The sample size was calculated using a single population proportion formula, assuming a confidence level of 95% (z = 1.96), a level of significance of α = 0.05, and a margin of error (d) of 0.05 for the three objectives ;to determine the magnitude of sever malaria, to determine outcome and to determine common complications. The sample size for the first objective p(22.03%) from study done in Ethiopia(5) is 295. for the second objective(28.32%) study done at democratic republic of Congo (31) is 348. for the third objective commonest complication was cerebral malaria(48.23%) (31) Is 427.the final sample size was the largest proportion, 427. Where;

$$ni = \frac{\left(Z\frac{\alpha}{2}\right)^2 * p(1-q)}{d^2}$$

– α= the level of significance 95%

– d= Maximum acceptable difference (5%)

– z α/2 = The value under standard normal table for the Given value of confidence level(1.96).

-10% added from the total sample size for non-response using formula

n/1-r, r non response rate.

Table1 proportion for sample size calculation from previous studies

Category	Prevalence (%)	n
1st prevalence	22.03	295
2nd outcome	28.32	348
3rd complication	48.23	427

3.5.2. Sampling procedure: The study population were listed based on their order of data collection (sampling frame). Computer generated samples using systematic random sampling technique was taken from the sampling frame the source population were 1025, and the study population were 827, k=1.9≈2, 1 was chosen as a starting point randomly then 1,3,5,7…

3.6. Data collection procedure: The data was collected from hospital log book and patient chart using structured questionnaire prepared from previous studies. Epi info version 7.2.6.0

and SPSS version 27 was used to enter, clean and analyze the data, respectively. And descriptive statistics (in the narrative form, tables, and charts) was used to document the result, multivariate Logistic regression analysis conducted to determine association between sever malaria and potential risk factors after each factors were analyzed with bivariate logistic regression to see if there is significant association. And was reported by the odds ratio at $p < 0.05$ with 95% confidence intervals. Training was given to the data collectors on the purpose and methods of data collection, pretest was conducted on 5% of the sample size and there was no any problem identified that needed modification before the actual data collection. The completeness of the data was reviewed daily throughout the process. Additionally, daily meetings and supervision sessions was arranged to address any challenges encountered during data collection.

3.7. Variables of the study

3.7.1 Independent variables:

Age

Sex

Residence (urban vs. rural) (near vs. far)

Income

Educational status

Use of ITN

Type of malaria species

Delay in seeking treatment

Presence of comorbidity

3.7.2. Dependent variable: dependent variable was complicated malaria

3.8. Ethical consideration: Ethical clearance was taken from collages of medicine and health science post graduate research coordinator office and the hospital administration accepted the ethical clearance and approved the research. Code/card number was used to hide the identities of study participants.

Chapter Four

Result

4.1. Socio demographic characteristics

A total of 427 under 5 year patients were studied and the response were 100% from these 236(55.3%) were male and 191(44.7%) were female.133(31.1%) were between the age of 1-11 month, 197(46.1%) were between the age of 1-3 years, 97(22.7%), were between the age 4-<5 years respectively.84(19.7%) were presented during winter, 122(28.6%) were presented during spring, 126(29.5%) were presented during summer and 95(22.2%)were presented during autumn respectively.38(8.9%) presented in 2020, 30(7.0%) in 2021, 61(14.3%) in 2022, 125(29.3(%) in 2023, 173(40.5%) in 2024 GC.107 (25.1%) of the patient presented from near and 320(74.9%) from far address relative to the hospital.

4.2. Magnitude of sever malaria and specious

From the specious of malaria, 233(54.6%) were plasmodium falciparum, 189(44.3%) plasmodium vivax, and 5(1.2%) mixed type respectively.190 (44.5%) of the malaria were complicated.

4.3. Complications of malaria

From complications of malaria, 114(60%) severe anemia, 40(21%) seizure, 20(10.5%) prostration, 10(5.3%) cerebral malaria, 4(2.1%) AKI, and 2(1.1%) hypoglycemia respectively.

4.4. Outcome of sever malaria

For the outcome of sever malaria 179(94.2%) were discharged improved, 1(0.5%) referred, 7(3.7%) left against medical advice, 3(1.6) and dead respectively.

Table 2 Socio demographic characteristics of study at wolkite university teaching and referral hospital, gurage zone, central Ethiopia, (N=427) from Nov-Dec, 2025

Variable	Category	Frequency (N)	Percentage (%)
Sex	Male	236	55.3
	Female	191	44.7
Age group	1–11 months	133	31.1
	1–3 years	197	46.1
	4–<5 years	97	22.7
Season of presentation	Winter	84	19.7
	Spring	122	28.6
	Summer	126	29.5
	Autumn	95	22.2
Year of presentation (GC)	2020	38	8.9
	2021	30	7.0
	2022	61	14.3
	2023	125	29.3
	2024	173	40.5
Residence	Near to hospital	107	25.1
	Far from hospital	320	74.9

Table 3 clinical Characteristics of study at wolkite university teaching and referral hospital, gurage zone, central Ethiopia (N=427) from Nov-Dec, 2025

Variable	Category	Frequency (n)	Percent (%)
Plasmodium species	*Plasmodium falciparum*	233	54.6
	Plasmodium vivax	189	44.3
	Mixed (*P. falciparum* & *P. vivax*)	5	1.2
Magnitude of severe malaria	Severe malaria	190	44.5
	Non-severe malaria	237	55.5
Complications of malaria	Severe anemia	114	60
	Seizure	40	21
	Prostration	20	10.5
	Cerebral malaria	10	5.3
	Acute Kidney Injury (AKI)	4	2.1
	Hypoglycemia	2	1.1
Outcome of severe malaria	Discharged improved	179	94.2
	Referred	1	0.5
	Left against medical advice	7	3.7
	Death	3	1.6

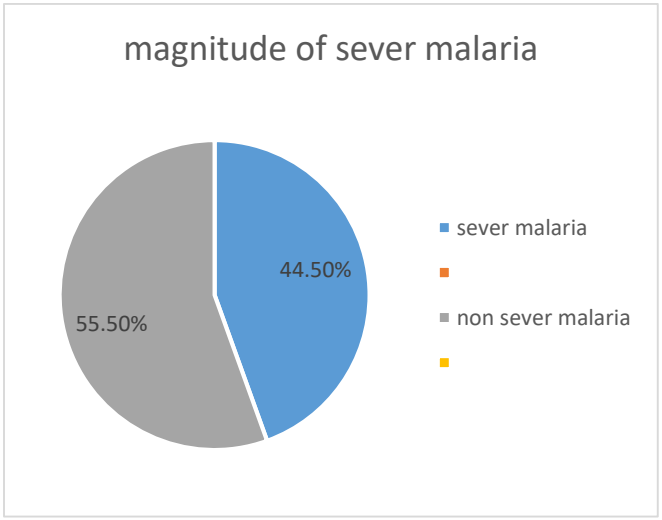

Figure 2 Magnitude of complicated malaria of study at wolkite university teaching and referral hospital, gurage zone, central Ethiopia (N=427) from Nov-Dec, 2025

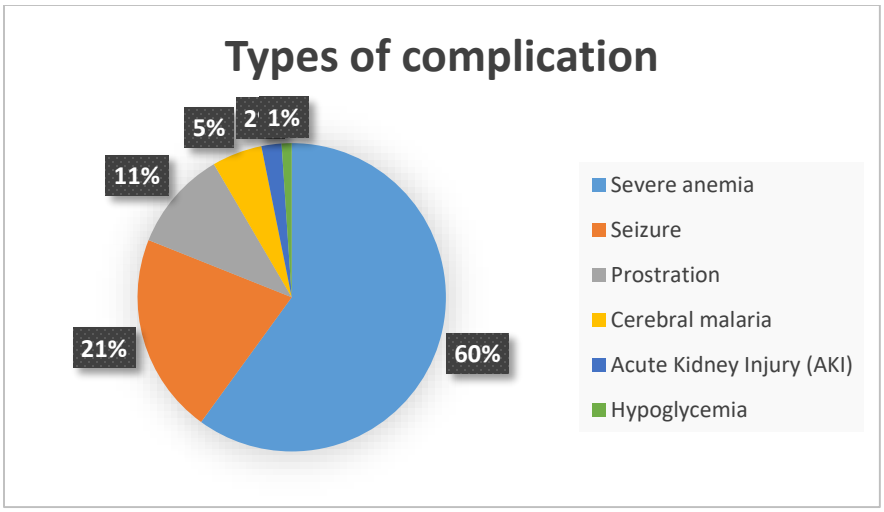

Figure 3 types of complications of study at wolkite university teaching and referral hospital, gurage zone, central Ethiopia (N=427) from Nov-Dec, 2025

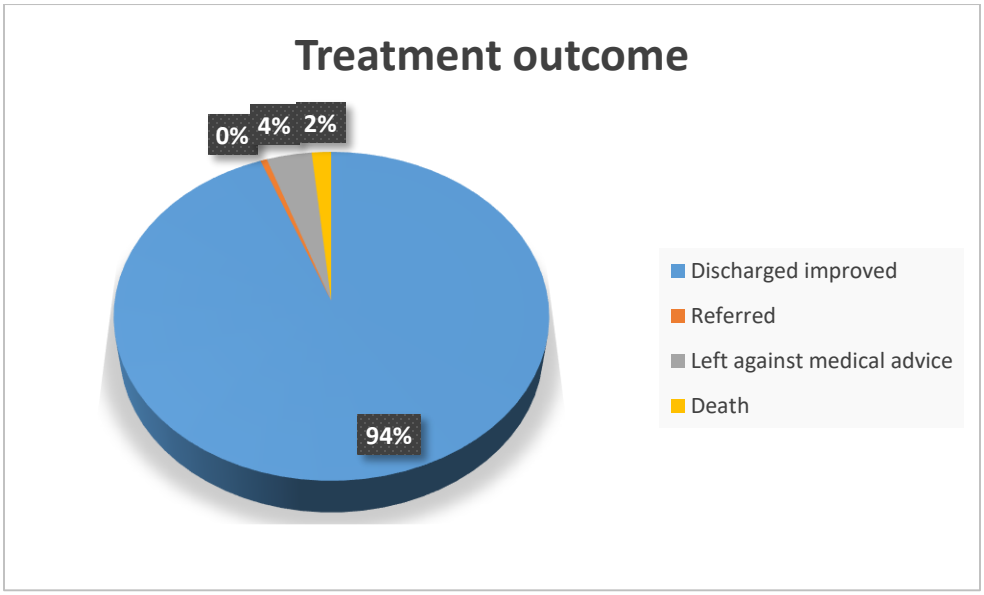

Figure 4 Pie chart of treatment outcome complicated malaria of study at wolkite university teaching and referral hospital, gurage zone, central Ethiopia (N=427) from Nov-Dec, 2025

4.5. Associated factors for sever malaria

Out of 427 participants, 192 (44.50%) had severe malaria. In multivariable analysis, season of presentation, duration of illness, and patient residence were independently associated with severe malaria. Children who presented during spring had 77% lower odds of developing severe malaria compared to those who presented during summer (AOR = 0.23; 95% CI: 0.10–0.55; p = 0.001). Since the adjusted odds ratio is less than 1 and the confidence interval

does not include 1, this indicates a statistically significant protective association.. Duration of illness was a strong predictor, with patients presenting after 2–7 days having markedly higher odds of severe malaria compared to those presenting within 1–2 days (AOR = 44.62; 95% CI: 23.01–86.53; p < 0.001). Additionally, residence influenced risk, as patients living near the health facility had significantly lower odds of severe malaria than those living farther away (AOR = 0.25; 95% CI: 0.11–0.57; p = 0.001). These findings highlight that delayed presentation, distance from healthcare, and seasonality are important determinants of severe malaria in this population.

Table4 Associated factors for sever malaria complicated malaria of study at wolkite university teaching and referral hospital, gurage zone, central Ethiopia (N=427) from Nov-Dec, 2025

Variable	Category	Severe Malaria Yes n (%)	Severe Malaria No n (%)	COR (95% CI)	AOR (95% CI)	P-value
Season of presentation	Summer (Ref)	80 (63.5)	46 (36.5)	1.00	1.00	—
	Spring	78 (63.9)	44 (36.1)	1.66 (0.66–4.17)	0.23 (0.10–0.55)	0.001
Duration of illness	1–2 days (Ref)	33 (13.4)	213 (86.6)	1.00	1.00	—
	2–7 days	159 (87.8)	22 (12.2)	46.65 (26.19–83.09)	47.24 (24.58–90.81)	<0.001
Address of patient	Far (Ref)	180 (56.3)	140 (43.8)	1.00	1.00	—
	Near	12 (11.2)	95 (88.8)	0.10 (0.05–0.19)	4.77 (2.10–10.84)	<0.001

Key: - 1=reference COR=crude odds ratio AOR=adjusted odds ratio CI=confidence interval

Chapter Five

Discussion

This study aimed in determining the magnitude of sever malaria, common complications, treatment outcome and factors associated with sever malaria in under 5 year children. In this study the magnitude of sever malaria was 44.5% which higher than a study done at pawe hospital (31.3%) (23) and Uganda (37.5%) (37). The lower magnitude at pawe could be due to older study than this study (published in 2016 GC.) and malaria has been increasing after the study, included children under the age of 10 years resulting in lower sever malaria because as a child gets older it acquires immunity due to previous exposure and less likely to develop sever malaria in addition, may be due to geographic difference. But the sampling technique and the duration of study were similar. The study done at Uganda only included patient admitted to pediatrics ward and the denominator were all under 5 year children admitted to the pediatrics ward resulting in lower value than this study because those with sever malaria and managed at emergency are not included. For complications, severe anemia was the most common complication (60%) which is comparable with studies done in Ethiopia (22, 23) the percentage was higher than the study (42%, 49%) respectively which may be due to smaller sample size and smaller magnitude of sever malaria than the study139 and 263 for the former 19 and 50 for the later respectively. Other complications are also common in decreasing order, seizure, prostration, cerebral malaria, AKI, hypoglycemia which is also comparable with studies done in Ethiopia, Uganda, DRC (11, 13, 22, 23, 31, and 37) but their order of frequency may vary. For the specious of malaria, Plasmodium falciparum was the most common cause followed by p.vivax and mixed falciparum and p.vivax which is comparable from studies in Ethiopia (11, 12,23,25).But different from another study done at wolkite HC in which plasmodium falciparum was second to plasmodium vivax (69.7% Vs. 29.3%) (26). For the treatment outcome, the mortality rate from the study was 1.6% which is lower than comparable studies which ranges from 8.5% to 28.32% (11,14, 15, 16,17 and 31) in high risk African countries. The lower rate in this study

could be due to earlier diagnosis, prompt and effective treatment, combined with supportive care like transfusion for sever malaria which can reduce mortality to below 5% in optimal settings (20). In the study most patients discharged improved (94.2%), 0.5% referred and 13.7% of patient left against medical advice and their fate is not known there is no published study to compare these treatment outcomes. For the associated factors, Season of presentation, duration of illness, and residence were independently associated with severity which is comparable to other studies (34, 35, and 36). Children who presented during spring had 77% lower odds of developing severe malaria compared to those who presented during summer (AOR = 0.23; 95% CI: 0.10–0.55; p = 0.001). Since the adjusted odds ratio is less than 1 and the confidence interval does not include 1, this indicates a statistically significant protective association., which is in contrast to study done at wolkite health center which showed spring is associated with sever malaria (6) may reflect seasonal variations in transmission and vector activity, consistent with observations in endemic regions where malaria peaks during or after rainy seasons. Duration of illness was a strong predictor, with those presenting after ≥2 days of symptoms being over 40 times more likely to develop severe malaria compared to those presenting within 1–2 days. This finding aligns with studies from Zimbabwe, Uganda, and Burkina Faso, which reported delayed care seeking as a major risk factor for severe malaria (AORs ranging from 4.53 to 9.03), emphasizing that delayed presentation allows the parasite to multiply and increases the risk of complications. Residence also influenced severity, with patients living near the health facility having lower odds of severe malaria, consistent with previous studies showing that greater distance from health facilities significantly increases the risk of severe disease (Zimbabwe AOR = 14.35; Uganda OR = 1.45; Burkina Faso OR = 6.66). These findings highlight the importance of timely healthcare seeking, improving access to medical facilities, and considering seasonal transmission patterns in malaria control programs, particularly in high-risk areas.

Chapter Six

Strength and limitation of the study

6.1 Strength: It is the first study with these specific title in our setup, included five years of data and the most vulnerable group in pediatrics.

6.2 Limitation: Only included under 5 children who visited our hospital with diagnosis of malaria and didn't study association of some of the factors to sever malaria like income, educational status due to lack of data from the sources since it is retrospective study and due to cross sectional study design causal relationship couldn't be determined

Chapter Seven

Conclusion and recommendation

7.1 conclusion: This study assessed the magnitude, complications, treatment outcomes, and associated factors of severe malaria among under-five children. The proportion of severe malaria observed was higher than in some previous reports, likely due to differences in study populations, settings, and inclusion criteria. Severe anemia was the most common complication, with other complications such as seizure, prostration, cerebral malaria, acute kidney injury, and hypoglycemia also identified. *Plasmodium falciparum* was the predominant species, followed by *P. vivax* and mixed infections. Mortality was low, reflecting early diagnosis, prompt treatment, and adequate supportive care, while most patients were discharged improved. Season of presentation, duration of illness, and residence were independently associated with severe malaria, emphasizing the importance of early care-seeking and geographic access to health services. Overall, severe malaria remains a significant public health problem, highlighting the need for strengthened early diagnosis, timely treatment, improved healthcare accessibility, and targeted seasonal malaria control interventions.

7.2. Recommendation

Morbidity and mortality from severe malaria among under-five children remain high, requiring coordinated efforts from multiple stakeholders. The Ministry of Health should strengthen prevention and control strategies, with special focus on vulnerable children and seasonal preparedness during high-transmission periods. Ensuring uninterrupted availability of antimalarial medications, diagnostic tools, and blood for transfusion is crucial, as early treatment and appropriate supportive care reduce mortality. Regional and zonal health offices should reinforce community-based prevention programs, monitor malaria trends, and ensure health facilities are adequately staffed and equipped during peak seasons. Strengthening referral systems and improving physical and financial access to healthcare, particularly in rural areas, is essential to minimize treatment delays. Health professionals should prioritize early diagnosis, prompt management, and appropriate supportive care, while educating

caregivers on seeking care promptly. Health Extension Workers should intensify community education on malaria prevention, early symptom recognition, proper use of insecticide-treated nets, and environmental control measures. Community engagement is critical, with parents and caregivers actively participating in prevention and timely care-seeking.

Since this study was hospital-based and limited to under-five children, findings may not fully represent the broader community burden. Variables such as household income, parental education, and net usage were not included due to the retrospective design and incomplete data. Further community-based and multicenter studies are recommended to explore additional determinants and provide a comprehensive understanding of factors associated with severe malaria.

Chapter Eight

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Chapter Nine

Appendix

APPENDIX A

QUESTIONENAIRE FOR THE RESEARCH ON MAGNITUDE ,CLINICAL OUTCOME OF SEVER MALARIA AND ASSOCIATED FACTORS AMONG CHILDREN LESS THAN 5 YEARS DIAGNOSED WITH MALARIA AT WOLKITE UNIVERSITY COMPREHENSIVE SPECIALIZED TEACHING AND REFERRAL HOSPITAL FROM SEPTEMBER 2013 – AUGUST 2017 EC.

1. MRN --------
2. Date of admission--------
3. Address---------
4. Age 1.1-11 month 2.1-3yrs 3.4yrs-<5yrs
5. Sex. 1. M 2. F
6. Is there a diagnosis of malaria? 1. Yes 2 No
7. Season of presentation
   1. Winter 2.spring 3.summer 4.Autumn
8. Duration of symptoms in days 1. 1-2 2.2-7 3. >7
9. Which specious of malaria found at laboratory
   1. Plasmodium falciparum 2. Plasmodium vivax 3.mixed (1 and 2)
   4. Other
10. Is there any comorbidity 1.yes 2.No
11. Is the malaria complicated? 1. Yes 2. No

    If the answer to question 11 is yes…then,

12. Forms of severe malaria
    1. Prostration 2.severe Anemia 3. Cerebral malaria 4. Seizure 5 hypoglycemia 6 AKI 7. Others
13. Duration of stay in the hospital in days 1.1-3 2.4-7 3. >7
14. Outcome at discharge 1. Improved 2. Death 3.Referred 4. Left against