TRENDS IN AGE OF CHILDREN OF < 10 YEARS WITH SEVERE MALARIAL ANAEMIA IN WESTERN KENYA, AND THEIR CAREGIVERS-ASSOCIATED FACTORS

BY

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DECLARATION

I hereby declare that this thesis is my original work and has not been submitted for award degree or any other award in any university. This thesis has been submitted for examination with the approval of my supervisors.

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DEDICATION

To my husband, Dr. Joel Odhiambo Gondi and children Don, Daisy, Darren and Diannah.

ABSTRACT

Severe malarial anaemia (SMA) in young children is the most common presentation of *P. falciparum* in western Kenya and accounts for 20% of inpatient admissions. The high morbidity and mortality caused by severe malaria has led to the scaling up of effective malaria interventions especially in endemic regions like western Kenya. In areas of high malaria transmission, infants and young children <5 years carry the biggest disease burden. Immunity against malaria develops with cumulative exposure as the person ages. Development of acquired immunity could be hampered by the development and implementation of malaria control strategies leading to a possibility of a shift in age of severe malaria infection from younger to older children. The practices of caregivers of SMA children towards their treatment also have an effect on the severity of malaria and could differ by the child's age. Therefore, the general objective of the study was to investigate the age trend of pediatric patients under 10 years old suffering from severe malarial anaemia and their caregivers' associated factors. Specific objectives were to evaluate the age trend of SMA in children <10 years, evaluate the care-givers' knowledge on recognition of SMA, assess the health care seeking behavior of the caregivers, determine the household and health care provider costs in management of SMA, and assess the clinical outcome of children <10 years with SMA in western Kenya. A cross-sectional survey was conducted at Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH) from September 2014 to July 2015. 271 children with SMA and their caretakers were enrolled and data collected through structured questionnaires. Chi-square test was used to determine differences between categorical data; Welch's t–test was used to compare means, and correlation analysis was used to evaluate relationships between continuous variables. SMA was found to be common in children <5 years 203(74.9%) than those > 5 years 68(25.1%) with a mean age of 39 months, thus a shift in age of children with SMA was not evident. Caregiver knowledge on recognition of signs and symptoms of SMA was found to be wanting for both <5 and those >5 years old. On health seeking behavior, majority of the caregivers gave some remainder drugs before presenting to a health facility, which was more common among children <5 years, followed by buying drugs from nearby stores. The average total household cost in treating SMA was $23.52. The average household cost per child was higher for children >5 years compared to their <5 group ($28.48 vs $18.55, p=0.01). However, the health care provider spent more on the children <5 compared to >5 ($13.56 vs $17.41, p=0.01). A total of 4 (1.5%) study participants had a fatal outcome, with equal percentages of deaths in the <5 and >5 age groups. In conclusion, a shift in age of SMA occurrence from younger to older children was not observed. It is however important to continue monitoring the trends as the malaria prevention methods continue to evolve and especially with the planned introduction of the malaria vaccine. The government should also educate caregivers on how to identify early signs of SMA and to avoid giving medication or other forms of delay prior to presenting in hospital. The government should also ensure that there are no stock outs of medicines and consumables used in SMA management for <5 years and consider introducing subsidies for those > 5 years also. The rate of death from SMA has also reduced, but children <5 and >5 have equal chances of death from SMA.

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LIST OF ABBREVIATIONSAND ACRONYMS

ACT	Artemisinin Combination Therapy
ANC	Antenatal Clinic
CHEW	Community Health Extension Worker
CHW	Community Health Worker
CHV	Community Health Volunteer
CM	Cerebral Malaria
EIR	Entomological Inoculation Rate
FGDs	Focused Groups Discussions
GMAP	Global Malaria Action Plan
Hb	Haemoglobin
HBM	Health Belief Model
HIV	Human Immunodeficiency Vitrus
IPTp-SP	Intermittent Preventive Treatment of malaria in pregnancy using Sulfadoxine-Pyrimethamine
IRS	Indoor Residual Spraying
ITNs	Insecticide Treated Nets
JOOTRH	Jaramogi Oginga Odinga Teaching and Referral Hospital
KIIs	Key Informant Interviews
LLITNs	Long-Lasting Insecticide-Treated bed Nets
MOH	Ministry of Health
MUERC	Maseno University Ethics Review Committee
NGO	Non-Governmental Organization
NHIS	National Health Insurance Scheme
OPD	Out- patient department
OOPS	Out of pocket spending
PCR	Polymerase Chain Reaction
PMI	Presidential Malaria Initiative
RBCs	Red Blood Cells
RBM	Roll Back Malaria
SMA	Severe Malarial Anaemia
WHO	World Health Organization

OPERATIONAL DEFINITION OF TERMS

Acquired immunity: The ability for the body to fight infections that is developed over your lifetime. The ability to fight infections is gained through exposure to, in this study, malaria over the person's lifetime.

Age pattern: The trends in age, which is observed as the number of children with SMA within each age range, <5 years and >5 years to <10years.

Caregiver: Person providing primary care to the child below 10 years with malaria. This could be the biological parents or another person (family member) tasked with this responsibility.

Healthcare provider: Hospital where the children were admitted for severe malarial anaemia management.

Healthcare provider costs: Costs incurred by the hospital where the children were admitted for management of SMA.

Household: A house and its occupants regarded as a unit.

Household costs: Costs incurred by the household to care for the child with SMA

Knowledge: The understanding of a specific subject matter, in this study, the ability to identify signs and symptoms of severe malarial anaemia

Prevalence: The proportion of a population who have a specific characteristic in a given time period, in this case, malaria.

Severe Malarial Anaemia: Hb<5.0 g/dL and any density of plasmodium parasitaemia

Shift in age: The change in occurrence of a disease (malaria) from one age group to another, in this case SMA occurrence in children >5 to<10 years from children <5 years.

Outcome of SMA- Clinical outcome, alive or dead and also duration of hospitals stay in relation to caregivers associated factors and age of child.

Trends in age: The age patterns in which an event is happening, in this case, the patterns in the age that severe malarial anemia is observed, be it mostly children below 5, or shifting to children above 5, or an equal distribution between age groups.

Treatment seeking behavior: The habits that caregivers have in terms of finding healthcare services for the child when experiencing malaria or severe malaria symptoms

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CHAPTER ONE
INTRODUCTION

1.1 Background information

Malaria is a severe disease caused by parasites of the genus *Plasmodium*, which is transmitted to humans by a bite of an infected female mosquito of the species *Anopheles*. It remains the leading cause of mortality around the world, and early diagnosis and fast-acting treatment prevent unwanted outcomes. It is the most common disease in Africa and some countries of Asia, while in the developed world malaria occurs as imported from endemic areas (Talapko et al.,2019)

In humans, it is caused by five Plasmodium species namely, *P. falciparum, P. vivax, P. ovale, P. malariae* and *P. knowlesi* (World Health Organization, 2018). *P.falciparum* is the major cause of severe morbidity and mortality(Zekar & Sharman, 2022). Infection with *P. falciparum* is being accounted for more than 90% of the world's malaria mortality and therefore remains an important threat to public health on a global scale (Snow R.W, 2015)

In 2019, there were an estimated 229 million cases of malaria in 87 countries**.** The estimated number of malaria deaths stood at 409,000 in 2019.The WHO African region carries a disproportionately high share of the global malaria burden. In 2019, the region was home to 94% of malaria cases and malaria deaths (World Health Organization, 2021). In Kenya, there are an estimated 3.5 million new clinical cases and 10,700 deaths each year, and those living in western Kenya, which is a holoendemic region for malaria, have an especially high risk of malaria (CDC, 2018).

Clinical symptoms accompanying a malaria positive diagnosis usually result from development of the *P. falciparum* in the red blood cells leading to destruction of the red blood cells (RBCs). These symptoms can, in some individuals, progress from the mild clinical form to a severe life-threatening form which is severe malaria. Severe malaria presents with overlapping clinical

sequelae that include severe malarial anaemia (SMA), metabolic acidosis, respiratory distress, cerebral malaria (CM) and hypoglycemia (World Health Organization, 2021). In *P. falciparum* holoendemic transmission areas such as western Kenya, severe malaria is a predominant cause of under-five morbidity and mortality (Ondeto et al., 2022; Zekar et al., 2022)occurring primarily as severe malarial anaemia (SMA, Hb<5.0 g/dL and any density parasitaemia) (Rowe et al., 2009). SMA in young children is the most common presentation of *P. falciparum* severe malaria (World Health Organization, 2021). Some of the factors leading to development of SMA in malaria include sequestration of RBCs infected with the parasite, suppression of RBC production in the bone marrow, and reduction and dysregulation of immune responses (Helleberg et al., 2005). SMA amounted to an estimated mortality in 274,000 children under-fives globally in 2019 (World Health Organization, 2021). In western Kenya, it was reported to be the most common cause of *P. falciparum* deaths(Kapesa et al., 2018). A previous study revealed that 18% (N1067) of children who were admitted with *P. falciparum* infections, 21% of them were admitted with SMA, which contributed to 53% of malaria-related deaths (Obonyo et al., 2007).

The burden of deaths from severe malaria has seen the scaling up of effective malaria interventions globally (more so in Africa), and a decreasing trend in malaria burden in sub-Saharan Africa (Hamre et al., 2020). Some of the interventions that have been used include, large-scale indoor residual spraying (IRS) campaigns, use of insecticide-treated bed nets (ITNs) and the introduction of artemisinin-based combination treatments (ACTs) (Karungu et al., 2019). Increased malaria prevention and control measures are dramatically reducing the malaria burden and as a result malaria related mortality rates have fallen by more than 25% globally since 2000 and by 33% in the WHO African Region (World Health Organization, 2017). In western Kenya, a reduction in the number of children admitted in hospital with SMA has also been recently

reported in some malaria endemic regions, owing to the intensive malaria control measures (Kapesa et al., 2018). These malaria control interventions have resulted in malaria decline as evidenced by reduced entomological inoculation rates (EIR). In 1994, the EIR in western Kenya was 50-300 (Beier et al., 1994). More recent studies have shown lower EIR than what it was before intensive malaria control strategies (Bayoh et al., 2014; Degefa et al., 2017). The most recent reports from Western Kenya reveal an EIR of between 26.9 to 48.2 specifically in Nyakach Sub-County of Kisumu County (Otambo et al., 2022).

In areas of high transmission, the burden of severe malaria morbidity and mortality is concentrated in young children and is less in older children and adults. This has been attributed mainly to early acquisition of functional immunity to clinical disease (Rogers K.J et al.,2021) Older individuals develop acquired immunity over time as they get more exposure to the plasmodium parasites. In areas of stable malaria transmission, clinical immunity to malaria develops by the age of 5 years (Barry & Hansen, 2016) but in areas with low unstable malaria transmission, it has been shown that age-related protection from malaria develops slowly or does not occur at all (Noland et al., 2008). In regions where malaria is endemic, acquired immunity is delayed because the development and implementation of malaria control strategies reduce the chances and frequency of exposure to malaria at a young age. This then leads to a possible shift in age of severe malaria-infected children from younger to older children (Bouyou-Akotet et al., 2009; Doolan et al., 2009). An earlier study carried out in India showed a higher prevalence of *P. falciparum* malaria in children between 5-10 years compared to their younger counterparts aged 0-5 years (Kochar et al., 2010). A previous study based in Cameroon reported that children between 6-19 years had a higher attributable risk of anaemia caused by malaria than younger children aged 0-5 years (Sumbele et al., 2016). The majority of studies on prevalence and

immunity against malaria and severe malarial anaemia have however evidenced that children below 5 years of age are more susceptible to developing the disease. Despite availability of literature regarding a possible age-shift (Björkman et al., 2019; Coulibaly et al., 2021), the current trends in age of SMA infection in children below 10 years resident in holoendemic *P. falciparum* transmission regions of erstrn Kenya remains unknown. As such, the study aimed to determine the SMA infection age patterns of children 10 years and below resident in Western Kenya.

Early recognition of to severe malarial anaemia by the primary caregivers is essential to ensure that children are brought to the formal health care system. In children, malaria usually presents with symptoms including fever, chills, rigors, sweating, headaches, lethargy, myalgias, and cough (Kafai et al., 2018). Gastrointestinal symptoms may occur and include nausea, emesis, diarrhea, and abdominal pain. There may also be end-organ involvement in the malaria infection including pallor, tachycardia, hepatosplenomegaly, jaundice, and increased respiratory rate, and altered mental status in cerebral malaria (Kafai et al., 2018).

Understanding community's knowledge towards childhood illness is important in developing appropriate interventions (Cyril et al., 2015). The ability of caregivers to adequately recognize signs of severe malarial anaemia has the potential to markedly increase the proportion of children with SMA who are brought to the attention of the health care system promptly (Dhabangi et al., 2019). A recent study in west Ethiopia showed that the majority of caregivers could recognize malaria by its symptoms in children under 5 (Mitiku & Assefa, 2017). In Nigeria, a community Advocacy, Communication and Social Mobilization included training caregivers to recognize malaria symptoms in young children to enable them seek healthcare in good time (Nwaneri et al., 2017). In Uganda, early recognition of malaria symptoms by caregivers has led to better health

outcomes for children under 5 (Kassam et al., 2016). In holoendemic*P. falciparum* transmission settings of western Kenya, information is limited on the ability of primary caregivers to recognize crucial signs of SMA for instance pallor, in their children. There has been an initiative in Western Kenya focused on creating awareness for caregivers to recognize fever as a symptom of malaria, but no other symptoms were discussed (Wasunna et al., 2015).

A number of studies have provided evidence that if caregivers receive some training in identifying pallor at different anatomical sites, they are able to do it thus better outcomes for their children. (Dhabangi et al., 2019; Sumbele et al., 2013). Some studies have also documented evidence that without training, caregivers rarely are able to identify severe SMA thus poor outcomes for their children (Olumide et al.,2014),

With the possibility of a shift in age of severe malaria occurrence, it is important that caregivers are able to recognize severe anaemia in children at different ages. This knowledge is yet to be assessed for caregivers of children suffering from SMA in western Kenya. There is also no information regarding differences in caregivers' ability to recognize severe malaria symptoms between children <5 and children aged 5-10 years in Western Kenya, since the majority of studies have focused on children<5 years. As such, the study determined the caregiver's knowledge on the recognition of severe malarial anaemia in children under 10 years old in western Kenya, assessing possible differences in symptoms recognition between the two age groups.

Early diagnosis and appropriate treatment are essential to reduce morbidity and mortality related to malaria in children (Landier 2016). It is critical for caregivers to have an early recognition of moderate to severe anaemia by the primary caregiver to ensure that these children are brought to the formal health care system.The health care seeking behaviour of caregivers, which informs the

choice of treatment, has been found to be influenced by accessibility, disease type, and severity, patient's gender and parent's educational level(Nwaneri, 2020; Nwaneri, 2017; Kasaam, 2016; Mitiku, 2017; Wasunna 2015). Since most children cannot fend for themselves, time of intervention, healthcare option and quality of care received, depend on the actions of the caregivers which ultimately determines the outcome of a disease. For instance, a study in Nigeria found that the mortality rate of severe malaria was 15 per 1000, and 94% of the deaths were children whose caregivers did not have appropriate health-seeking behaviour (Nwaneri & Sadoh, 2020). In Nigeria, a different study found that home-based management of malaria delayed the time taken by the caregiver to take the child to a healthcare facility, which eventually lead to worse clinical outcomes (Nwaneri et al., 2017).

However, home management of malaria using analgesics showed more positive clinical outcomes than caregivers who decided to observe the child until the fever was too high (Kassam et al., 2016). Another study showed that caregivers who sought healthcare from traditional healers and tried home treatment before ending up at the health facility had worse health outcomes (Mitiku et al., 2017). In western Kenya (Bondo District), an initiative aimed at improving prompt (same day) health seeking behaviour to a health facility improved the clinical outcomes for children under 5 with malaria (Wasunna et al., 2015). Older children rarely get SMA, but with the possibility of shifting ages of severe malaria attack, older children may start to present with this disease. If there is a shifting age, there could also be differences in healthcare seeking behaviour of caregivers of children <5 years and children > 5 years. However, there is little information regarding the differences in healthcare seeking behavior of caregivers of children under 5 years and 5-10 years with severe malaria. As such, the study assessed the health

seeking behaviour of caregivers of sick children who had SMA, and how this differed between the different age groups (below 5 and above 5), and what impact this could have had in recovery.

Malaria impedes development by its effect on fertility, population growth, worker productivity, absenteeism, premature mortality and medical costs(Mbacham 2019). Costs incurred by the caregivers while seeking medical care for a sick child can have major impacts on the financial stability of affected families. This is further complicated by the fact that a big proportion of households affected by malaria are in the low-income economic category and rural setting. A study that previously assessed the cost burden of malaria in rural Kenyan households showed that almost 8% of household costs was dedicated to malaria healthcare (Chuma et al., 2006). Another Nigerian-based study that assessed the cost of in-patient and out-patient treatment of malaria ranged between USD 12-24 (Onwujekwe et al., 2013). However, there has been a downward trend in malaria cases from the year 2002 attributable to scaling up of malaria control interventions, notably, distribution of insecticide-treated bed nets especially the long lasting insecticide treated bed nets (Zhou et al., 2011). This downward trend is expected to lead to significant savings in hospital and household resources used for treating malaria. However, with the possibility of a shift in malaria burden to the older children, it is still unclear whether there will be a concomitant shift in costs to the older children.

The healthcare provider and household resources needed and association with this shift in age of infection remains unclear. Currently, the average cost of treating inpatient SMA in children under- five years of age in western Kenya remains unknown. It is also unknown what it will cost to treat older children (<5 to <10 years) compared to those <5 years, especially those resident in a holoendemic *P. falciparum* transmission regions such as in western Kenya. As such, the study determined the cost of treating inpatient SMA infection in < 5 years and those >5 to < 10 years in

western Kenya. Most deaths resulting from SMA occur within 24 hours of admission (Loannidis, L. J et al., 2014). A study by (White, 2022) found out that children who are admitted with severe anaemia and do not survive succumb quickly, nearly half the deaths within 12 hours of admission.

This calls for a heighted need for early decision-making regarding the need for transfusion and availability of screened banked. The duration of the illness before presenting to hospital has an effect on the outcome of the disease (Armstrong et al., 2002). Some practices, like the use of herbal concoctions before presenting to a health facility may lead to poor prognosis (Eseigbe et al., 2012). In malaria, children who have been admitted usually exhibit higher parasitaemia. The length of admission correlates to the amount of time required to clear the parasite and its symptoms using chemical prophylaxis (Gonçalves et al., 2014). Cases of SMA often require hospitalization and blood transfusion and any delay in getting this treatment or an otherwise malpractice performed by the caregiver on the sick child may produce adverse outcomes (Obonyo et al., 2007). With the possibility of shifting burden of malaria to older children, it is of interest to know the outcomes of SMA in older children. The study sought to find out the medical outcome of children diagnosed with SMA in western Kenya, and whether this differed between age groups. In addition to data about the medical outcome, the study also assessed how the duration of admission was related to the medical outcome, how the child's age was related to the length of admission, and how health seeking behaviour influenced the length of admission.

1.2 Problem statement

It has been reported that in malaria endemic areas, acquisition of immunity against malaria is delayed due to development and implementation of malaria control strategies. This delay can lead to a possibility of a shift in age of SMA-infected children from the younger to older children

(Bouyou-Akotet et al., 2009). In holoendemic regions of *P. falciparum* transmission in western Kenya, control efforts against malaria have been intensified in the past few decades and malaria incidences have gone down (Tizifa et al., 2018). A recent study estimated the prevalence of SMA in coastal Kenya as 60% of all severe malaria cases(Watson et al., 2022)A previous study in western Kenya reported that of 1116 hospital admissions, 83% had malaria, SMA accounted to 21% of malaria-related admissions, and 53% of malaria-related deaths (Obonyo et al., 2007). However, despite the consistent high prevalence of SMA in Kenya, it is currently unknown whether the trends in age of children affected with SMA could have changed from the expected below 5 years or could have shifted to older children (above 5 years) in western Kenya, which is holoendemic for malaria. The level of knowledge on recognition of malaria by caregivers will determine whether or not, or how fast caregivers seek medical attention from health care facilities and other available health care options.

A lot of control efforts have been focused on educating caregivers of children below 5 years (Novelli et al., 2010; Olaka et al., 2019). The level of knowledge of caregivers on how to recognize symptoms of SMA in children below 5 and above 5 years in western Kenya also remains unknown. Knowledge of the symptoms will usually affect the next step taken by the caregiver, which is to seek health care. Health care seeking behavior is a determinant of success or failure of medical intervention, if any, and the affected child's clinical outcome(Wasunna et al., 2015).However, the health seeking practices by caregivers of children suffering from severe malaria in western Kenya, and possibility of differences in these behaviors based on the child's age group is unknown. Available literature has only highlighted health seeking behaviors for caregivers of children below 5 (Were et al., 2018). The available options sought by caregivers are also pegged on the cost they will incur for the child to recover. A previous study assessing

the household and healthcare facility cost of malaria recruited children and adults, but did not assess differences in cost based on age (Watts et al., 2021).It is, however, also unclear whether any differences in the trends in age of children with SMA will result to changes in the costs incurred both for provider and caregiver in the management of SMA in different age groups. The final aspect of follow up of a child with malaria is to evaluate their clinical outcome. If there is a difference in trends of age of children with SMA, their clinical outcome will also be interesting to evaluate across the different ages. This study, therefore, set out to establish the current trends in age of children with SMA in western Kenya, and how the associated caregiver factors might differ with the trends in age.

1.3 Objectives

1.3.1 Broad Objective

To investigate trends in age of children of < 10 years with severe malarial anaemia in western Kenya, and their caregivers-associated factors.

1.3.2 Specific Objectives

i. To determine trends in age of children <10 years with SMA in western Kenya.
ii. To evaluate the care-givers' knowledge on recognition of SMA in children <10 years in western Kenya.
iii. To assess the health care seeking behavior of the caregivers of children <10 years with SMA in western Kenya.
iv. To determine the household and health care provider costs in management of SMA in children <10 years western Kenya.
v. To assess the clinical outcome of children <10 years with SMA in western Kenya.

1.3.3 Research Questions

i. What is the age trend of children <10 years with SMA in western Kenya?

ii. What is the caregivers' knowledge on the recognition of SMA in children <10 years in western Kenya?

iii. What is the health care seeking behavior of the caregivers of children <10 years with SMA in western Kenya.

iv. What are the household and health care provider costs in the management of SMA in children <10 years western Kenya?

v. What is the clinical outcome of children <10 years with SMA in western Kenya?

1.4 Significance of the study

In malaria endemic areas, such as western Kenya, the development of acquired immunity in children is being hampered by the development and implementation of malaria control strategies, which are mostly targeted towards children <5 years. This can possibly lead to a shift in age of severe malaria infection, including SMA, from younger to older children (Doolan et al., 2009). This study endeavored to find out the current trends in age of children below 10 years to investigate a possible shift in age of children affected with SMA. It also looked at the possible downstream effects of these trends in age in relation to their caregiver factors. This study has contributed to the current knowledge on the age trends in children with SMA from western Kenya. This information will help policy makers and stakeholders in healthcare to better identify the ages at risk of SMA and thus develop more robust control measures. The study has also provided information about the associated factors in relation to the age of the children with SMA. These factors include the caregiver's recognition of SMA, health seeking behaviors, cost of managing SMA for children in different age groups and clinical outcome of SMA. This information will guide policymakers on the most appropriate approaches to better inform and

enable caregivers to care of children with SMA based on their ages, to eventually improve health outcomes of children under 10 with SMA.

1.5 Justification of the study

The study was focused on finding out the current trends in age of children <10 years with SMA in western Kenya. This will inform health stakeholders and policy makers in malaria control about where to focus their control efforts against malaria. Caregivers also play a big role in the management and health outcome of children with SMA. The information about caregiver associated factors and how these differed between caregivers of children below 5 years and those between 5-10 years is important for policy makers to understand the needs and factors of caregivers with regards to the different age groups of children with SMA.

1.6 Assumptions of the study

The study was based on several assumptions. First, the study assumed that the two age classes, <5 and >5 are random and representative samples of the population of children below 10 from Western Kenya. Second, the study assumed that both children <5 and >5 are equally likely to be admitted. Third, the study assumed that children of both ages and their caregivers are both equally likely to participate in the study.

1.7 Limitations of study

In calculating the household costs incurred during SMA occurrence, the current study did not include the indirect costs as a result of the caregivers loses of working hours as they were taking care of the sick child. Another limitation of the current study is that data on costs was collected on recall basis and trusting that the information was accurate. Although the time period of collection of cost data was short, between a few hours and a few days, with a sick child, a caregiver can easily forget the specifics about the costs used especially for costs like transport for which they may not be issued with receipts. Finally, the study fell short in lacking qualitative

data from Focused Groups Discussions (FGDs) and Key Informant Interview (KIIs) including health care workers, policy makers, community health workers and volunteers, which would have given more information about their perceptions on caregiver factors that influence SMA.

CHAPTER TWO
LITERATURE REVIEW

2.1 Malaria

Malaria is transmitted by mosquitoes of the anopheles' family (Adedeji et al.,2020). These mosquitoes transmit the malaria parasite, protozoa of the Plasmodium genus, from an infected host to an uninfected person during feeding of the mosquito.(Djihinto et al.,2022).

It is the most common disease in Africa and some countries of Asia but in the developed world malaria occurs as imported from endemic areas (Talapko et al.,2019).

Majority of malaria cases in sub-Saharan Africa are attributed to the *Plasmodium falciparum* species (Zekar & Sharman, 2022). Other *Plasmodium* species including *P. malariae, P. vivax, P. knowlesi* and *P. ovale* also cause malaria but rarely (World Health Organization, 2018).

Clinical symptoms accompanying a malaria positive diagnosis usually result from development of the *P. falciparum* in the red blood cells leading to destruction of the red blood cells (RBCs). (White, 2022).

These symptoms can, in some individuals, progress from the mild clinical form to a severe life-threatening form which is severe malaria. Severe malaria presents with overlapping clinical sequelae that include severe malarial anaemia (SMA), metabolic acidosis, respiratory distress, cerebral malaria (CM) and hypoglycemia (World Health Organization, 2021)

Initial symptoms malaria include fever, headache and chills and these *P. falciparum* symptoms, if untreated, can progress into severe malaria (White, 2022).

In 2021, there were about 247 million reported cases of malaria in 84 malaria endemic countries globally, and this resulted in about 619,000 deaths in the same year (WHO, 2022). The WHO

African region carries a disproportionately high share of the global malaria burden as the region in 2019 was home to 94% of malaria cases and malaria deaths with young immune naive children under 5 years being most vulnerable.(World Health Organization, 2021). This is in part as a result of the tropical climate in sub-Saharan Africa which supports the survival of the mosquito vector and the plasmodium parasite (Lindsay et al., 2021) The poor economic status of the region also makes it difficult to control the vector mosquitoes, increasing the chances of parasite transmission (Oleribe et al., 2019)

In Kenya, there are an estimated 3.5 million new clinical cases and 10,700 deaths each year, and those living in western Kenya, which is a holoendemic region for malaria, have an especially high risk of malaria (CDC, 2018).Four components are involved in the human malaria transmission system: (i) the protozoan parasite *Plasmodium*, (ii) the human host, (iii) the mosquito vector and (iv) a given environment.(Castro M. C. 2017).Strategies developed to control this disease, targeting the vector has significantly reduced malaria incidence across Africa. (Bhatt et al., 2015). The current vector control programs rely mainly on the use of chemical insecticides through the insecticide-treated nets (ITNs) with pyrethroids and the indoor residual spraying (IRS) with organophosphates and carbamates (Monroe et al., 2020)

The purpose of these conventional tools is to reduce vector density below the threshold required for transmission or to prevent human-vector contact.

2.2 Severe malarial anaemia age trend in children <10years

The World Health Organization (WHO) defines SMA as Hb concentrations <5.0 g/dL (or a hematocrit <15.0%) in the presence of any density parasitemia (World Health Organization, 2021). SMA is caused by several often-overlapping features, including lysis of infected and uninfected RBCs, splenic sequestration of RBCs 19, dyserythropoiesis, bone marrow

suppression, and co-infections with bacteremia, HIV-1, and hookworm.(Davenport et al., 2010). Some or all of these factors can culminate in chronically low Hb values observed in infants and young children residing in holoendemic regions.SMA is the most prevalent presentation of severe malaria and it amounted to an estimated mortality in 274,000 children under-fives globally in 2019 (World Health Organization, 2021). In sub-Saharan Africa, severe malaria which primarily presents as SMA is the leading cause of paediatric morbidity, hospitalization and mortality (Brejt & Golightly, 2019). A recent study estimated the prevalence of SMA in coastal Kenya as 60% of all severe malaria cases (Watson et al., 2022). Data collected from 4 hospitals in Western Kenya between 2015 and 2018, revealed that SMA accounted for 1057/2340 (45.2%) of severe malaria admissions. (Akech et al., 2020).In areas of high malaria transmission, infants and young children carry a very high disease burden but they develop protective immunity in early childhood (WHO, 2021). In these areas, clinical immunity to malaria develops by the age of 5 years (Rolfes 2012).

The immunity develops with cumulative exposure as the person ages. Adults and older children are able to control parasitaemia and therefore rarely suffer from severe malaria (Rolfes 2012). In areas of low malaria transmission, immunity develops slowly and malaria affects all age groups (Gonzales et al., 2020). This is as a result of poorly developed immunity to malaria because of infrequent exposures thus making them vulnerable to severe clinical illness and complications from Plasmodium infection. In areas endemic for malaria, the development and implementation of malaria control strategies have hampered the development of acquired immunity leading to a possibility of a shift in age of severe malaria infected children from the younger to older children (Pemberton-Ross 2015).The general principle behind acquired immunity has been that, in areas where the intensity of transmission is higher, more persons are exposed to infection, exposure to

infection occurs earlier, partial immunity develops earlier, and the risk of severe malaria decreases (Barry and Hasen 2016).In Kenya, various control strategies have been employed that has resulted in decrease of morbidity and mortality. Some of these strategies are vector control mainly on the use of chemical insecticides through the insecticide-treated nets (ITNs) and the indoor residual spraying (IRS) (Monroe et al., 2020). Recently also being piloted is the malaria vaccine in some parts of western Kenya (Laurens, 2020). In 2001, Kenya adopted ITN use policy which involved the distribution of free or highly subsidized ITNs through antenatal clinics (ANC), expanded programmes of immunization services, child health action days, community-based initiative and retail outlets to children under-five and antenatal mothers (Zhou et al., 2016). Indoor residual spraying (IRS) have been employed on highland and epidemic prone districts and case management, first line antimalarials Artemisinin-based combination therapies (ACTs) have been made accesible in the private sectors through subsidy schemes and at all public health care levels, including community health workers (Zhou et al., 2016).

As a result of deployment of these strategies, a decline in the burden of malaria in Kenya has been observed in recent years resulting in low malaria transmission intensity in most parts of the country (Björkman etal., 2019). A study in Ghana assessed malaria cases before the scale up of malaria control methods including ITNs and indoor residual spraying between 2005 to 2010, and the period after the scale up, from 2015. The study showed a 57% reduction of malaria incidences in the general population. The study also showed a 50% reduction in outpatient children patients aged below 5 years, a 46% reduction in admissions, and 70% reduction in deaths of children with malaria (Aregawi et al., 2017). The study however did not include older children. In yet another cross-sectional study done in Northern Tanzania, (Manjurano et al., 2011), surveys carried out during short rainy seasons to compare between microscopic and

polymerase chain reaction (PCR) parasite prevalence, the difference between parasite prevalence by PCR was 3.2 in individuals aged between 15 and 45 years as compared to 2.5 in those aged 1-5 years. The highest prevalence was observed in the middle (5-14 years) age group and was lowest in adults (15-45 years). This was another show of higher susceptibility of children above 5 to malaria. However, adults already have an established immune system, and are protected from infection, explaining the lowest prevalence in adults. In Kenya, a survey was conducted to assess the trends in malaria transmission between 1990 and 2014 including 69,104 children from Kilifi County. The results showed a decline in the proportion of admitted < 5 years with malaria parasites on blood testing from 1998 to 2009. This is the period when ITNs were intensely distributed among households in Kilifi County (Mogeni et al., 2016). However, there was a steady and marked increase in the proportion of admitted children >5 years with malaria parasites in their blood from 2009 to 2014. A study in western Kenya looked at the prevalence of malaria in schoolchildren aged 3 to 18 years old.

The study found that in the lowlands, individuals of aged 5–14 showed significantly higher prevalence than those under age 5 (Lo et al., 2015). A more recent study compared malaria and severe malaria in three different transmission areas, Marani (epidemic prone), Iguhu (mesoendemic) and Kombewa (hyperendemic). Severe anaemia malaria at the hyperendemic site was witness to only 14.3% of admissions and as low as 3% in other study areas. The number of severe malaria cases was highest among the ≥15 years old with 51.5% and the lowest among the <5 years old with only 17.3% (Kapesa et al., 2018). The study found a higher prevalence of malaria and severe malaria in older children compared to those <5 years, evidencing a shift in age of malaria infection in this region (Kapesa et al., 2018). Another study, still in western Kenya, sampled children aged 1month to 15 years from four county hospitals in Busia,

Kakamega, Vihiga and Kisumu. This study, on the contrary, found that malaria was still more prevalent in children <5 years compared to older children (Akech et al., 2020). The current study, therefore, sort to assess the current trends in age of children aged 10 and below with SMA.

2.3 Caregiver's knowledge on the recognition of SMA in children<10years

In children, malaria usually presents with symptoms including fever, chills, rigors, sweating, headaches, lethargy, myalgias, and cough (Kafai et al., 2018). Gastrointestinal symptoms may occur and include nausea, emesis, diarrhea, and abdominal pain. There may also be end-organ involvement in the malaria infection including pallor, tachycardia, hepatosplenomegaly, jaundice, and increased respiratory rate, and altered mental status in cerebral malaria (Kafai et al., 2018).

Understanding community's knowledge towards childhood illness is important in developing appropriate interventions (Cyril et al., 2015). The ability of caregivers to adequately recognize signs of severe malarial anaemia has the potential to markedly increase the proportion of children with SMA who are brought to the attention of the health care system promptly (Dhabangi et al., 2019). Integrated Management of Childhood Illness (IMCI) guidelines categorizes general danger signs of under-five childhood illnesses as: unable to breastfeed, unable to drink or eat, vomiting everything, convulsion and lethargy/unconscious. A study by (Ringsted et al., 2006) indicated that mothers were able to identify danger symptoms and signs early, and took action against them within 24 hours. These included prostration/lethargy, unable to sit or to be carried on mothers back, or sleeping all time. Despite existing high prevalence of SMA among children, most parents recognize weakness as the main complaint among anaemic children well rather than paleness (Olumide et al., 2014; Whitburn et al., 2011). The problem with this is that caregivers may end up managing weakness at home by nutritional support, fluid intake, instead of taking

the child to a heath facility for blood transfusion. A study by (Maduka et al., 2019) on parental perception of childhood anaemia and efficiency of instrument assisted pallor detection among mothers in south Nigeria aimed to evaluate parental ability to detect pallor when aided with home-based anaemia-screen tool. Majority (88.8%; 270/304) of the parents aided with the home-based anaemia-screen tool were able to detect pallor. Their detection of anaemia compared reasonably well with the clinical assessment for pallor done by healthcare workers. Without the tool, 18.3% knew sites on the body where pallor can be detected. A qualitative study by (Dhabangi et al., 2019) in 3 referral hospitals in Uganda, in-depth interviews (IDIs) and focused group discussions (FGDs) was used to collect data on recognition of signs and symptoms of severe anaemia among children. The signs of severe anaemia among children were well articulated and appeared to be fairly well understood by both interviewees and FGD respondents who described them with ease. Generally, the signs commonly mentioned included bodily changes, mainly of the eyes, face, feet or legs, and the palm or hands. Specifically, conjunctival pallor or jaundice, feet or facial oedema, and paleness of the palms and the tongue were common signs for severe anaemia reported by many respondents.

Even though severe anaemia was identified to be a serious disease and majority felt blood transfusion was the ideal treatment, concomitant use of traditional and home remedies was also widespread. This study was nested in an on-going clinical trial on post-discharge malaria chemoprevention among children recently treated for severe anaemia. Their knowledge on how to recognize severe anaemia may have been influenced by knowledge they may have gained while the child was admitted. A study by on knowledge and perception of caregivers of febrile children with malaria at the Dalhatu Araf Specialist Hospital Lafia Nasarawa state, Nigeria found out that caregivers who had had prior contact with health professionals were more

knowledgeable than those who had not (Hassan et al., 2022).In a study on factors associated with a poor treatment outcome among children treated for malaria in Ibadan, Southwest Nigeria (Olumide et al.,2014), Caregivers listed rigors, loss of appetite, vomiting, jaundice, pallor, loss of consciousness, and convulsion as symptoms they observed in their wards, however, more children were noted to be jaundiced, pale, and anaemic on clinical examination and following laboratory investigations conducted at the hospital compared with the caregiver's self-report of these symptoms and this implied that many of these symptoms were missed by the caregivers. The author reports this might have been the reason why a higher percentage of children who were not pale or jaundiced based on their caregiver's report had a negative health outcome. A study in Cameroon (Sumbele et al., 2013), anaemia in children with *P. falciparum* infection, prevalence, risk factors and perceptions by caregivers were investigated. The study revealed that majority of caregivers were aware of pallor as a symptom of anaemia, but none could detect whether the child was anaemic before assessment of hemoglobin concentration. The caregivers were unable to recognize paleness of the conjunctiva and palms, which were more apparent in those children who had severe anaemia.

Closer home, in another study carried out in Asembo Bay in western Kenya (Desai et al., 2002), pallor was recognized to be associated with severe anaemia, and further revealed that the caregiver's could recognize severe anaemia (Hb<5.0g/dl, any density parasitaemia) using pallor albeit with moderate accuracy. However, in that study, the caregivers received some training in identifying pallor and the different anatomical sites used for identifying this condition prior to collecting information. This might have influenced the test characteristic, thus making the results less representative of what might happen in real life situations.

In trying to improve the services for children at risk of dying of SMA, it is important to understand the knowledge of the caregiver's who make decisions about treatment. Recognition of signs and symptoms of severe malarial anaemia by the caregivers is essential in ensuring that these children are brought to the formal health care system.

With the possibility in shifts of age of severe malaria attacks, it is important that caregivers are able to recognize severe malarial anaemia in children at different ages, especially in *P. falciparum* holoendemic transmission regions such as western Kenya. As such, the current study determined the level of caregivers' knowledge on the recognition of severe malarial anaemia in children under 10 years old in western Kenya, and whether this differed for caregivers of <5 years and >5 to <10 years.

2.4 Health care seeking behavior among caregivers of the children <10 years with SMA

Poor, delayed, or inappropriate health seeking for a sick child with acute childhood illness is associated with high morbidity/mortality. Delay in health seeking is implicated with fatal complications and prolonged hospital stay (Wambui et al., 2018) Thus, caregivers ought to identify danger signs and promptly seek professional help for a sick child. Naturally. caregivers play a pivotal role in the provision and care for childhood diseases. Since most children cannot fend for themselves, time of intervention and quality of care received, depend on the actions of the caregiver and ultimately determines the outcome of a disease. A study on health-seeking behavior for childhood ailments by caregivers of under-five children in an urban resettlement colony in Delhi, India revealed that the health-seeking behavior of caregiver mothers of under-five children in a low-income neighborhood was non-uniform. They sourced from a variety of licensed and unlicensed practitioners, pharmacists, traditional healers, and frontline workers. Apart from self-medication, utilization of government health facilities by caregivers for their

children, except for immunization services, was low due to low satisfaction with staff behavior. Obtaining health-related information from internet-based sources was also becoming more common, indicating the need for caregivers and young mothers to be educated on identifying trustworthy sources of health information (Sharma et al., 2022). A study by (Nwaneri et al., 2020 on the effect of health seeking behaviour of caregivers on severe malaria outcome in under-fives seen in a tertiary health institution in Nigeria found out that, the commonest place visited for initial healthcare before presentation was the patent medicine vendors by 87 (73%) caregivers. Seventy-seven per cent of caregivers who did not have appropriate health-seeking behaviour were from the lower family social class The mortality rate of severe malaria was 15 per 1000; of which 94% were children whose caregivers did not have appropriate health-seeking behaviour. Age younger than 2 years significantly predicted mortality in the children irrespective of the caregivers' health-seeking behaviour status. In another study in urban Malawi Slums by (Lungu et al., 2020) on determinants of healthcare seeking for childhood illnesses among caregivers, 61% of caregivers sought healthcare albeit 53% of them sought healthcare late. Public health facilities constituted the most frequently used health providers.

Healthcare was more likely to be sought: for younger than older under-five children when illness was perceived to be severe. Home management of childhood illness was negatively associated with care-seeking and timely care-seeking. Caregivers with good knowledge of child danger signs sort care timely. In Uganda, a study by Sundararajan et al., 2015) revealed that 2 categories explain delayed care, 1) sociocultural and 2) structural factors. Sociocultural factors were interviewee's distinctions of "traditional" versus "hospital" illnesses, which were mutually exclusive and generational conflict, where deference to one's elders, who recommended traditional medicine, was expected. Structural factors were, inadequate distribution of health-care

resources, impoverishment limiting escalation of care, and financial impact of illness on household economies. The study was a qualitative that sought to characterize barriers to prompt allopathic care for children hospitalized with severe malaria in the endemic region of southwestern Uganda. A study by (Wambui et al., 2018) on determinants of health seeking behavior among caregivers of infants admitted with acute childhood illnesses at Kenyatta national hospital, Nairobi, Kenya revealed that Poor knowledge on danger signs of infancy was common among caregivers blurring the magnitude of acute illness resulting in delayed health seeking. The study concluded that knowledge ability of danger signs of infancy, high educational level, and being married were associated with immediate health care seeking. Unlike the current study, it focused on infant admitted with any acute childhood illness. Other studies (Apuleni et al., 2021) has also documented relationship between level of education and marital status as affecting health seeking behavior.

In the Kenyan cost, an in-depth interview with 53 mothers, fathers and caregivers from two rural clinics at the Kenyan Coast revealed that, purchase of over the counter medicine was found to be the most popular first point of treatment. Traditional healing also played a salient role in the health care within the two communities. Traditional healers were consulted for various reasons: a) attribution of causation of ill-health to supernatural sources, b) chronic illness (inability of modern medicine to cure the problem) and c) as prevention against possible ill-health. It was also noted that, there was a complex process involving consultation at various levels, with elders, but also between both parents, depending on the perceived nature and chronicity of the illness. However, it was reported that fathers were the ultimate decision makers in relation to decisions concerning where the child would be taken for treatment. A systematic review by (Mousa et al., 2020) on impact of delayed treatment of uncomplicated P. falciparum malaria on progression to

severe malaria revealed that there is relationship between rapid access to treatment and reduced risk of severe disease. The use of health care options has a direct influence on the outcome of SMA. As such, it would be important to offer improvement in the management through alternative health care options administered by the caregivers before presentation to the health facility. As such, the current study assessed the health care seeking behavior among caregivers the sick children who had SMA, in less than 10 years old in western Kenya.

2.5 The economic burden of severe malarial in children<10years

Although the magnitude of human suffering due to malaria is well known and a wide range of research about malaria prevention and effective treatment is on-going, there is wanting knowledge about the cost of treating malaria in hospitals and specifically SMA.A recent study based in Ghana sought to determine whether or not interventions such as the National Health Insurance Scheme (NHIS) and Community-based Health Planning and Services (CHPS) have reduced the economic burden of malaria to households (Dalaba et al., 2018). The study determined that direct medical and non-medical costs associated with treating an under-five child with malaria were US$4.13 and US$3.04 respectively, and the overall average direct and indirect medical and non-medical costs was US$4.91. Another study in Mozambique sought to assess the cost of treating uncomplicated and severe malaria.

Median household cost for children under five was USD 1.63 per uncomplicated case and USD 64.90 per severe case (Alonso et al., 2019).In a rural district in Burkina Faso, the average actual provider's cost for malaria treatment was 6.74 US$ for a paediatric out-patient with malaria, 61.08 US$ for a paediatric malaria inpatient with anaemia and, 74.29 US$ for a case of paediatric malaria with neurological infection. The study aimed at estimating the provider's cost of treating paediatric cases of malaria and did not include household costs incurred and also

focused only on children below 5 years (Koné et al., 2010).When Free treatment policy for malaria in children under the age of 5 years was introduced in Kenya in the year 2005, it was expected that such a shift would improve financial access to treatment by the poorest patients, but households frequently pay for hospital stay and/or drugs and supplies (henceforth all termed 'user fees'). The majority of these payments made by households directly to service providers. A study done by (Caroline et al., 2021) at a hospital in western Kenya revealed that the mean health system cost per patient was USD 42.0). The total household cost per patient was USD 16.4 and consisted of: USD1.6 medical costs; USD 7.1 non-medical costs; and USD 7.7 indirect costs. The total societal cost (health system and household costs) per patient was USD 58.4. The study involved all infants, children, adolescents and adults admitted to the hospital with a diagnosis of malaria between June 2016 and May 2017.

This study also included spatients with comorbidities associated with malaria i.e chest infection, diarrhoea and anaemia. Another study by (Kodhiambo et al., 2020) entitled household cost of paediatric malaria treatment in a rural county in Kenya involving 13 health facilities ranging from level II to level V in Homa Bay County revealed that the total household costs were, USD3.36 at level lI hospital, USD 5.87 at level III hospital, USD 20.63 at level IV hospital and USD 23.83 at level V hospital. The study targeted children below 13 years and malaria in general. To date, studies have tended to focus more on the costs associated with malaria in general and direct costs. Data on indirect costs incurred at the household level is wanting and so is cost specifically involved in the management of SMA. Furthermore, it is unknown what it costs to treat older children. With the possibility of a shift in the severe malaria anaemia to older age group, this study determined the provider and household costs in treating SMA in children<5 years as compared to 5-10 years in western Kenya.

2.6 Outcome of severe malarial anaemia in children <10 years

Recovery or death of a child admitted to hospital with severe malarial anaemia depends on a number of factors. These include the knowledge of the caregiver on recognition of severe anaemia, which will influence their health care seeking behavior, which is how soon they see a professional health care provider. The cost incurred by the caregiver or the household in the treatment of a child with SMA can also influence the medical outcome, for example, opting for cheaper options such as self-medication or consulting local herbalists could result in the death of a child who required professional help sooner.

Cases of severe anaemia often require hospitalization and blood transfusions.The duration of the illness before presenting to hospital has an effect on the outcome of the disease (Kagabo et al., 2018). In a previous study (Obonyo et al., 2007), it was revealed that there was an increase in the risk of mortality among transfused severely anemic children. The study findings showed that these children were sicker or were hospitalized too late so the available interventions could not save them. In yet another study (Eseigbe et al., 2012), it was found that the time of presentation to the health facility for children with SMA was delayed, with a big proportion of children being brought to the health facility 2 days after the onset of symptoms thus leading to adverse outcomes. The study demonstrated that there was a high rate of mortality in those who had used herbal concoctions before presenting to the health facility and death in severely anemic children occurred soon after admission highlighting the need for early decision-making regarding the need for blood transfusion.

The studies above both focused on children who were below 5 years old. A study by (Machini et al., 2022) found out that, hospital length of stay in patients admitted with suspected malaria was determined by early recognition and appropriate management of the signs of malaria. Caregivers

associated factors can also result in prolonged hospital stay which can lead to increased costs, an increased risk of complications, and decreased patient satisfaction (Sahiledengle et al., 2020). The current study collected data on the caregivers' knowledge, health care seeking behavior, and cost of treatment, it was important to tie it in with the medical outcome of children admitted with SMA and highlight any patterns in children < 5 years and > 5.

2.7 Theoretical Framework

This study was informed by The Health Belief Model (HBM). It hypothesizes that health-related behavior, in this case caregivers' factors related to children below 10 years with SMA, depends on a combination of several factors. These factors include perceived susceptibility, which in this case is related to the knowledge of symptoms of SMA. Second, perceived severity of the health problem which is also related to the knowledge of symptoms. Third and fourth, health-related behavior depends on perceived benefits and cues to action, which in this case are caregiver health seeking behaviours as they seek for the child to get better, and the household cost of managing children <10 years with SMA. The last factor is self-efficacy which is the confidence in one's ability to perform the health behavior in question, in this case it is also the health seeking behaviour of the caregivers.

2.8 Conceptual framework

Malaria control strategies i.e. use of ITNs, ACTs, IRS targeting under-fives, can hamper development of acquired immunity leading to a possibility of shift of SMA(Noland et al., 2008). A shift in SMA can result in changes in economic burden of SMA to household and provider as evidenced in a previous study (Sicuri et al., 2013). There is little information about the effects of differences in age on the caregivers' ability to recognize severe malaria via general danger signs and physical exam, and thus the aim of this study to investigate the same. Children's age has

been shown to influence the caregivers' health seeking behavior(Were et al., 2018).Finally, the study assessed the effects of children's age on morbidity and mortality due to SMA, with previous studies showing a relationship between age and mortality of children with SMA (World Health Organization, 2021). The conceptual framework is summarized in Figure 2.1 below.

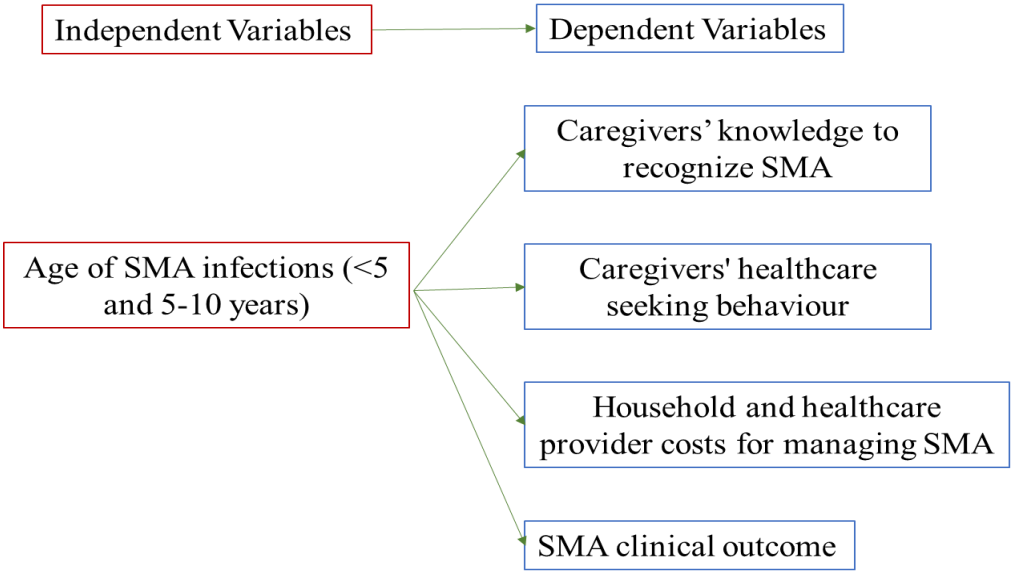

Figure 2.1: Conceptual framework

CHAPTER THREE
METHODOLOGY

3.1 Study area

The study was conducted at Jaramogi Oginga Odinga Teaching and Referral Hospital (JOOTRH) located in Kisumu City of western Kenya, around Lake Victoria, an area that is holoendemic to malaria and experiences stable *P. falciparum* transmission (altitude 0-1300 meters, Appendix 1,(King et al., 2015). JOOTRH is the largest referral hospital in western Kenya hospital serving a catchment area with a population of more than 5 million people in more than 10 counties in the western region of Kenya (Owenga & Nyambedha, 2018). It has been used as a representative health facility for western Kenya in several studies (Burmen et al., 2017; Okumu et al., 2018; Owenga & Nyambedha, 2018).Nyanza region reports high levels of malaria cases. Data from Health Management Information System in JOOTRH shows that malaria accounts for 40% of out-patient visits and 20% of hospital in-patient admissions for pediatrics. (IRIN, n.d.). Malaria transmission occurs all year round, peaking in the rainy season months of April and May and continuing to August. The rain waters also expose a major reservoir for breeding of mosquitoes creating persistent malaria endemic environment. The region experiences warm climate of 20-30°C throughout the year. The humid, warm and mostly swampy environment makes the area a prime breeding ground for the female anopheles mosquito, the vector for the malaria parasite(IRIN, n.d.).

3.2 Study design

This was a hospital inpatient based cross-sectional study. Data was collected from September 2014-July 2015, a period of 11 months. The study was considered cross-sectional because each study participant was sampled once within this 11-month period, and there was no follow-up.

The period also spans across a whole year, representing data collected from both dry and rainy seasons, making the observed trends more representative of all seasons. Information from study participants were collected from the day of admission until the day they were discharged. A hospital-based cross-sectional study surveys a sample of a hospital's patients at one-time point based on their condition or infection. In this case, the study sampled children aged 10 years and below diagnosed with SMA at JOOTRH at one-time point. In this case, data was collected from September 2014 to July 2015.

3.3 Study Population

The study aimed to get information about children, who are <10 years diagnosed with severe malarial anaemia, i.e. hemoglobin concentration <5.0 g/dl (and any density *P. falciparum* parasitaemia) and based on WHO definition (WHO, 2000). Data from Health Management Information System in JOOTRH shows that malaria accounts for 40% of out-patient visits and 20% of hospital in-patient admissions for pediatrics. (IRIN, n.d.).

3.3.1 Inclusion criteria

i. All children <10 years diagnosed to have SMA
ii. Informed consent provided by the caregivers
iii. Caregivers of the enrolled children agreeing to be interviewed
iv. Children residents of western Kenya.

3.3.2 Exclusion criteria

i. Children with known haemoglobinopathies e.g sickle cell anaemia or cancers as these can also cause severe anaemia. The cause of the Severe anaemia in these cases will not be caused by malaria and thus my skew the data intended to be collected.
ii. Children with other comorbidities i.e Pneumonia, malnutrition

iii. Mentally challenged caregivers

3.3.3 Sample size determination

The following sample formula used to for calculating sample size for prevalence studies was used(Naing et al., 2006).

$$n=\frac{Z^2p(1-p)}{d^2}$$

where

n= the desired sample

z= Z statistic for a level of confidence,

p=expected prevalence or proportion

d=precision

The prevalence of inpatient admission with malaria in the health facility is 20%, (based on prevalence of Malaria admissions in Western Kenya according to (Kapesa et al., 2018). Z statistic to be used is at 95% which is conventional with a Z value of 1.96 and the precision is set at 0.05 so as to obtain a 5% margin of error.

$$\frac{(1.96)^2\ (0.2)\ (0.8)}{(0.05)^2} = 245.8$$

This gave an estimate of 246 participants. This gave an estimate of 246 participants. Plus 10% for non-responders (Sakpal, 2010; Graham,2015), the sample size came the sample size came to 271. All the caregivers of the 271 children enrolled in the study were also interviewed.

3.4 Sampling procedure

Convenience non-probability sampling design was implemented. Convenience sampling involves using respondents who are “convenient” to the researcher, in this case, children who

presented to JOOTRH and were diagnosed with SMA, and their caregivers The non-probability sampling method selects units from a population using a subjective (i.e. non-random) method. In this case, only patients diagnosed with SMA and their caregivers were sampled for the study.As patients presented to the health facility and diagnosed of SMA, they were approached for consent to participate in the study. This went on until the desired sample size was achieved.

3.5 Data Collection instruments/tools

A structured questionnaire was used to collect data(Appendix 2). Some of the information that was captured by the questionnaire included, demographic information such as age and gender of the child, dates of admission, investigations, vital signs at admission, and whether they met the inclusion criteria. To confirm consistency, these details were confirmed from the patient's medical file. To add to the information about a possible shift in age, the questionnaire also asked the caregivers about the malaria control methods in use by the household where the child is an inhabitant, and their history including the use of bed nets, IRS and ACTs. The questionnaire also included questions regarding the caregivers' knowledge on how to recognize SMA and their actions before reporting to hospital with a sick child, including their level of education as a possible explanation for some of these actions. Information about the costs incurred by the household and the service provider to treat the SMA affected child included data on expenses on laboratory tests, drugs, ward admission and transport. This information was collected regarding the current malaria treatment expenditure, which reduced the recall time to a few hours or days, therefore minimizing recall bias.

Caregivers of the patients were interviewed on the costs incurred pre-admission and during the admission. These costs were confirmed from their payment receipts, and captured on the structured questionnaire.

3.5.1 Pre-test

Before the final data collection tool was used for the study data collection, a pre-test was carried out on the designed questionnaire. The pre-test targeted 30 participants; the sample size recommended for a pre-test (Perneger et al., 2015). The questionnaire was tested in a small private health facility in Kisumu City.

3.5.2 Reliability

The ease and efficiency of collecting data through the questionnaire was evaluated. Ambiguous or unclear questions were edited and clarified. Any missing questions were added, and unnecessary questions were deleted from the final questionnaire.

3.5.3 Validity

The questionnaire was then reviewed by a consultant health social scientist to advise on its validity and reliability. Based on the theoretical framework that informed this study, the health beliefs model, information on the questionnaire was assessed to ensure it evaluated the requirements of the theory.

3.6 Research procedure

Data was collected with the help of qualified medical personnel who were recruited as research assistants. They were trained on the research objectives, protocol and data collection tools. When patients got admitted in the ward, they checked the admission notes to find out their age, and whether they had diagnosis of severe malarial anaemia based on malaria positive slides, and a Hb level below 5g/dL. They then checked the laboratory reports to confirm the presence of parasitaemia and Hb levels. The patients and caregivers were then evaluated to assess whether they met the inclusion criteria. The research assistants then approached the caregivers and obtained informed consent to participate in the study. If positive, they went ahead and collected

the required study information through the interview questions. The research assistants read the questions out loud to the participants, read the multiple-choice responses for close ended questions, then recorded the participant responses on the questionnaire. Only complete questionnaires were considered in the study, so data was collected until they achieved 271 complete questionnaires. Data was entered into an Excel document, then coded before being transferred to SPSS package and Graphpad Prism software for analysis.

3.7 Data processing and analysis

3.7.1 Data processing

To ensure that data was accurate, legible and complete, upon discharge of a study participant, the data collector ensured that all the information needed for every field was appropriately completed.

3.7.2 Data Analysis

In order to determine severe malarial anaemia infection age patterns in children under 10 years old in western Kenya, categorical variables were presented by use of frequencies and percentages while continuous data were presented by use of mean and standard deviation. The prevalence of children admitted with severe malaria was stratified by age.

To determine the healthcare seeking behavior of the caregivers, the collected data was entered and stored on an excel spreadsheet. Statistical analysis was performed using GraphPad Prism 5, SPSS statistical package, and MS Excel. Health seeking behavior among the caregivers was determined by use of frequencies and comparing proportions. *P*-value >0.05 was considered statistically significant for all the analyses performed.

Regression analysis was used to quantify the degree of relatedness between pre-hospitalization measures and the delay in child admission or length of hospitalization. In addition, regression

analysis was used to assess the relationship between the age of the patient and delay in admission or length of hospitalization.

To determine the household's and providers' economic burden of malaria management, the costs were classified as all cash spending due to SMA illness at household and provider level. Household costs included spending on consultation, drugs, laboratory tests, bed charges, gifts, transport, special foods and any other costs that a household incurred due to illness. Provider costs included drugs, laboratory, ward charges and other charges to manage the disease. The average cost per child was calculated by summing up the mean cost per item for both household and provider expenditures. The costs were then disaggregated by age categories for <5 and >5 years and gender. The Welch's t-test was used to compare the proportions of the age categories and gender for different cost items. The Welch's t-test was used because it was the most appropriate analysis to test the null hypothesis, that there was no difference between the mean costs of treatment between <5s and >5s.

3.8 Ethical Consideration

Approval for the study was obtained from School of Graduate Studies (SGS) at Maseno University (Appendix 3). Ethical approval was obtained from Maseno University Ethical Review Committee (MUERC) (Appendix 4) and JOOTRH Ethics Review Committee (Appendix 5). A visit was made to the medical superintendent of JOOTRH, and the intention of doing the study at the hospital was shared. Permission was granted to conduct the study at the hospital. Informed consent was obtained from the caregivers of the sick children before being enrolled in the study. The informed consent form was translated to Luo and Kiswahili as these are the common languages spoken in this region (Appendix 6). Participation in the study was purely voluntary. A copy of the informed consent was given to the caregivers. All the information collected was

treated with a lot of confidentiality. The study volunteer's data could only be accessed by the study team who were collecting the data and supervisors from Maseno University were supervising the execution of the study. For data security, the data was password protected and could only be accessed by individuals with whom the password was shared. Since the data was collected after the study participants had been diagnosed with SMA, there was no potential for harm on the children or their caregivers as a result of this study. During publications, no study participant's identifiers that can be linked to a particular study participant were used.

CHAPTER FOUR
RESULTS

4.1 Introduction

This study was aimed at answering 5 specific research questions. These included analyzing whether there has been a shift in the age of children affected with SMA from <5 years to 5-10 years. This is thought to be a result of intensive malaria control strategies as reported from previous studies. In addition, the study analyzed the possible downstream effects of this shift in age. These included whether the caregivers of SMA positive children were able to recognize the disease in children <5 and >5 years, and how this recognition affected their health seeking behavior. The study also assessed the cost of treatment for children <5 and >5 years with SMA born by the caregivers/household, and by the medical facilities. Finally, the study looked at the medical outcome of children affected with SMA and how this differed for children younger or older than 5 years of age.

4.2 Response rate

Out of the 271 participants targeted for this study, and who consented to participate in the study, 271 fully responded to the questionnaires and survey questions (Table 4.1). Any participant who was not willing to complete the questionnaire to the end was not issued with the questionnaire to begin with.

Table 4.1: Response Rate

Questionnaires issued	271
Questionnaires returned	271
Response rate	100%

4.3 Demographic characteristics

Most of the children were below <5 years 203(74.9%). Those >5yrs were 68(25.1%) with males being more at 167(61.6%) and females 104(38.4%). Majority of the caregivers were in the age category of 19-24, 75(27.7%) and 25-29, 75(27.7%). Those above 40 years were 33(12.1%), 35-39 years were 21(7.74%) 30-34 years were 57(21.0%) and 10 caregivers (3.4%) were below 18 years. Most of the respondents had attained primary level of education 217(80.1%), followed by secondary education 40(14.8%), tertiary education 13(4.8%) and university education 1(0.4%) (Table 4.2).

Table 4.2: Demographic characteristics of SMA patients and their caregivers.

Variable	Frequency, n (%) N=271
Age of child with SMA	
< 5 years (min 0-max 59 months)	203(74.9)
> 5 years (min 60-max 121 months)	68(25.1)
Mean age in months	39.93
Gender of SMA child	
Male	167(61.6)
Female	104(38.4)
Age of caregivers (years)	
< 18	10(3.7)
19-24	75(27.7)
25-29	75(27.7)
30-34	57(21.0)
35-39	21(7.7)
> 40	33 (12.2)
Caregivers' level of education	
University	1(0.4)
Tertiary	13(4.8)
Secondary	40(14.8)
Primary	217(80.1)

Table showing the demographic structure of children below 10 years presenting with SMA. This includes information about children's gender, age, caregiver's age, and caregiver's level of education. This includes percentages of children or caregivers in every category.

4.4 Severe malarial anaemia age trend in children <10years

It was established that SMA was more common in children <5years 203(74.9%) and therefore no evidence of a shift in age from younger to older. Those who were >5 years constituted 68(25.1%). The mean age for the children who had SMA was 39.93 months (Table 4.2)

The larger proportion of the children who reported with SMA, 54 (19.9%), were below a year old. About 48 (17.7%) were a year old, 29 (10.7%) were 2 years, 45 (16.6%) were 3 years old and 27 (10%) were 4 years old. Children above 5 years were as follows; 25 (9.2%) were 5 years, 12 (4.4%) were 6 years, 11 (4.1%) were 7 years, 9 (3.3%) were 8 years, 8 (3%) were 9 years, and 3 (1.1%) were 10 years. ($p<0.001$) (Figure 4.1). A Goodness of fit test showed that the distribution of children within ages was significantly different from the expected distribution in the null hypothesis ($p<0.001$).

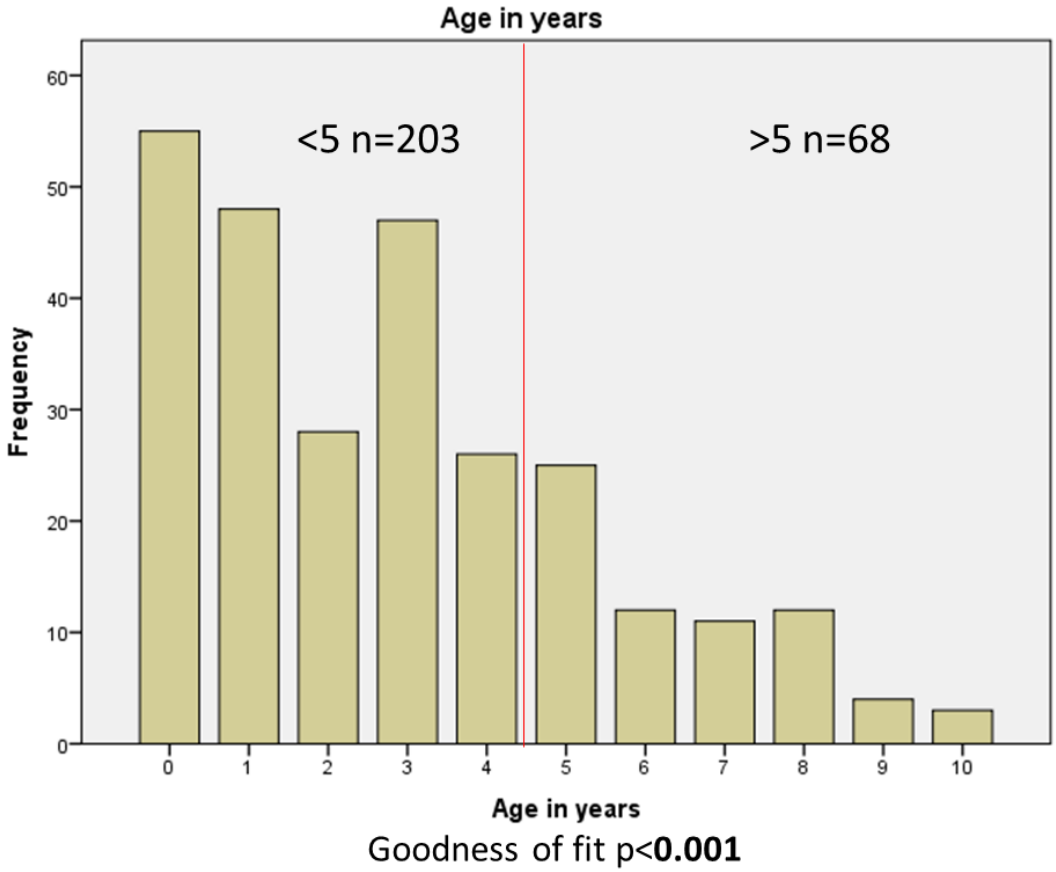

Figure 4.1: Age pattern of children 10 years and below with SMA

4.5 Caregiver's knowledge on the recognition of SMA in children <10years

4.5.1 Recognition of SMA by caregivers

The caregivers were asked what symptoms they expect to see in a child with severe anaemia. For caregivers of children <5 years, 49 (25%) stated weak bodies, 57 (30%) stated the children fed poorly, 17 (9%) said the children ate soil, 29 (15%) said difficulty in breathing, 28 (15%) said the children were unable to sit or drink, and 13 (7%) mentioned other symptoms. On the other hand, for the caregivers of children >5, 25 (39%) stated weak bodies, 16 (25%) stated the children fed poorly, 2 (3%) said the children ate soil, 12 (19%) said difficulty in breathing, 7 (11%) said the children were unable to sit or drink, and 2 (3%) mentioned other symptoms (Figure 4.2).

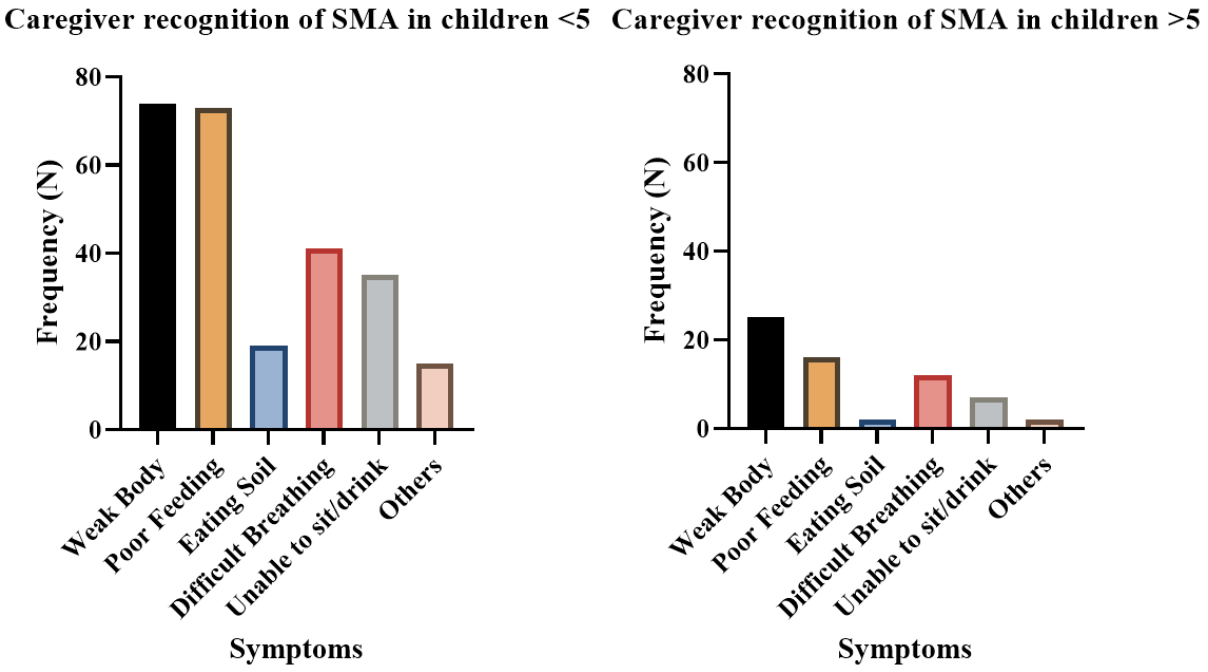

Figure 4.2: Caregiver's recognition of severe malarial anaemia symptoms

4.5.2 Caregiver's recognition of SMA by physical examination

The caregivers where asked what they would expect to see in a child with severe anaemia by physical examination. For caregivers of children <5 years, pale skin was stated by 50 caregivers (22%), palm pallor was mentioned by 46 (20%), nail pallor by 35 (18%), 79 (35%) reported eyelid pallor, 9 (4%) reported tongue pallor, and 9 (4%) reported other signs (Figure 4.3). On the other hand, for caregivers of children >5 years, 15 (21%) reported pale skin, 19 (26%) reported palm pallor, 14 (19%) reported nail pallor, 21 (29%) reported eyelid pallor, 2 (3%) reported tongue pallor, and another 2 (3%) reported other signs (Figure 4.3).

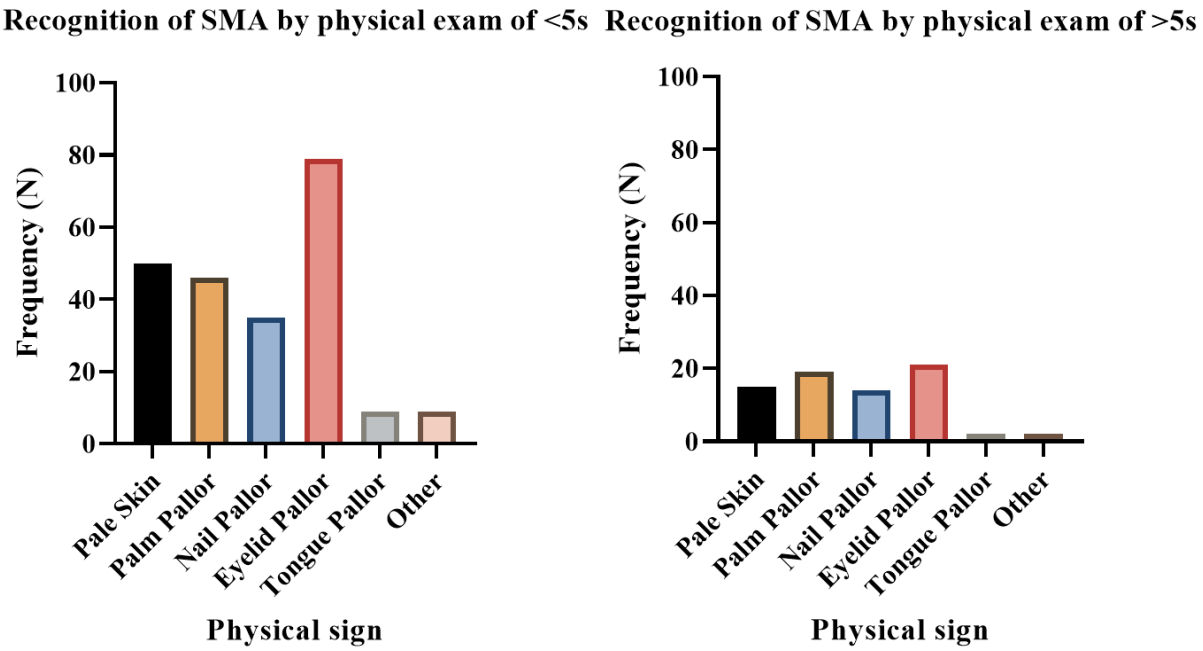

Figure 4.3: Caregiver's recognition of SMA by physical examination

4.6 Health care seeking behavior among caregivers of the children <10 years with SMA

4.6.1 Actions taken by caregiver pre-hospitalization

The caregivers were asked what actions they took before taking the children to hospital. For caregivers of children under 5, the largest proportion, 69 (39%) used remaining drugs, followed by 54 (30%) who bought drugs from a nearby store. 32 (18%) went to the community health worker, 22 (12%) used herbs, and 2 (1%) did not take any actions. For caregivers of children above 5 years, the larger percentage of caregivers, 34% (N=21) reported they bought drugs at a nearby store, followed by 31% (N=19) who used the remaining drugs and 27% (N=17) who went to see a community health worker. 5 caregivers (8%) used herbs (Table 4.3).

Table 4.3: Actions taken pre-hospitalization

Pre-hospitalization measures	<5 years Frequency n (%)	>5 years Frequency n (%)
Bought drugs at nearby drug store/private pharmacy	54 (30)	21 (34)
Traditional healer	0 (0)	0 (0)
Use herbs	22 (12)	5 (8)
Community health worker	32 (18)	17 (27)
Used remainder drugs	69 (39)	19 (31)
No action taken	2 (1)	0 (0)

Table showing the frequency and percentage of caregivers' actions they took before visiting the hospital, for children under 5 and children above 5 years.

4.6.2 Action taken pre-hospitalization and duration (days) before hospitalization

An ANOVA was carried out to evaluate the difference between days before hospitalization from the caregivers' actions taken pre-hospitalization. For children <5 years, results showed that those who bought drugs from a nearby store (p=0.430), visited a traditional healer (p=0.251), and visited a community health worker (p=0.778) did not show any significant variance in days before hospitalization. However, days before hospitalization were significantly different in the participants who used the remainder drugs (p=0.014).

For children >5 years, results showed that those who bought drugs from a nearby store (p=0.406), visited a traditional healer (p=0.787), visited a community health worker (p=0.384), and used remainder drugs (p=0.949) did not show any significant variance in days before hospitalization (Table 4.4).

Table 4.4: Action taken pre-hospitalization and duration (days) before hospitalization

		<5 years			>5 years		
		SS	**F**	**Sig.**	**SS**	**F**	**Sig.**
Bought Drugs	Between Groups	1.995	1.018	0.430	1.585	1.050	0.406
	Within Groups	37.640			12.930		
	Total	39.635			14.515		
Used herbs	Between Groups	1.215	1.267	0.251	.283	0.558	0.787
	Within Groups	18.401			4.349		
	Total	19.616			4.632		
Community health worker	Between Groups	.870	0.640	0.778	1.433	1.085	0.384
	Within Groups	26.086			11.317		
	Total	26.956			12.750		
Used remainder drugs	Between Groups	4.889	2.309	**0.014**	0.471	0.305	0.949
	Within Groups	40.658			13.220		
	Total	45.547			13.691		

Table showing the sum of squares (ss), F statistic, and significance (Sig.) of ANOVA test of different pre-hospitalization actions and delay days before hospitalization for children <5 and > 5 years.

4.6.3 Level of education and duration (days) taken before hospitalization

A correlation was carried to evaluate the relationship between education level and days taken before the caregiver sought intervention. For children <5 years, there was a slight non-significant negative correlation between education and days to intervention (correlation -0.010, p=0.891). For children >5 years, there was a slight non-significant positive correlation between education and days to intervention (correlation -0.080, p=0.517). (Table 4.5)

Table 4.5: Caregiver's level of education and days taken before hospitalization

		<5 years		>5 years	
		Education	**Days to Interventio**	**Education**	**Days to Interventio**
Education	Pearson	1	-0.010	1	0.080
	Sig. (2-tailed)		0.891		0.517
	N	203	203	68	68
Days to Intervention	Pearson	-0.010	1	0.080	1
	Sig. (2-tailed)	0.891		0.517	
	N	203	203	68	68

Table showing the Pearsons correlation and significance of caregivers' education and days taken before intervention for caregivers of children <5 years and > 5 years.

4.7 The economic burden of SMA in children<10years

All costs have been represented in dollars, using an estimated conversion rate of $1=KES100.

4.7.1 Household Costs

Expenditures incurred to treat children with SMA were analyzed using the Welch's t-test for unequal sample sizes (Statskingdom.com) to compare differences between children <5 years and those between 5-10 years old. An overall assessment of household cost showed that almost all, 270 (99.6%) out of the 271, study participants incurred some costs on treating their child infected with SMA. The average expenditure per child was $21.05, ranging from a minimum of $1.20 to a maximum of $70.52. Of these, 202 were children <5 years who incurred an average total of $18.55 per child, and 68 were children >5 years who spent an average total of $28.48 which was significantly higher ($p<0.01$).

Out of all the SMA positive children, 63 (23.2%) households represented incurred laboratory costs with an average expenditure of $5.98 ranging from $1.9 to $28.40. These included 23 (39.5%) children <5 years, and 40 (63.5%) children between 5-10 years. The average costs

incurred in the laboratory were slightly higher in children <5 years ($6.53) compared to the older group ($5.77), though not significant (p= 0.654).

About 194 (71.6%) households incurred the cost of purchasing drugs for their SMA affected children, averaging to $7.32 (min $0.30 - max $26.40), comprising 139 (71.6%) children <5 years and 55 (28.4%) children >5 years. Children <5 years spent significantly less money ($5.83 vs $11.09, p=0.01) on purchasing drugs compared to their older counterparts.

A large percentage (78.6%, n=213, mean $11.68)) of households recruited in the study spent their money on ward-associated costs ranging from $2.2 to $19.7. Out of these 213 children, 152 (71.3%) were those <5 years and 61 (28.6%) were >5 years old. The older children incurred slightly but significantly higher costs ($12.77) in the ward compared to those below 5 years of age ($11.24;p=0.01).

All but one of the study participants incurred transport costs, 270 out of 271 (99.6%), spending an average amount of $2.32 ($0.20 to $20.80). Of these, those below 5 years were 202 (74.8%) children, and 68 (25.2%) were above 5 years. Transport costs were slightly higher for children above 5 years ($2.47) compared to children <5 years ($2.28). This difference was, however, not statistically significant (p=0.55).

Other expenses such as purchase of blood giving set, branulas needles and syringes were also incurred by 117 (43.3%) of the participants during SMA treatment. The average expenditure on other costs was $6.59 ranging from $0.7 to $14.7. The 117 was made up of 74 (63.2%) children <5 years and 43 (36.8%) children > 5 years. Households with children below 5 years spent an average of $8.41, which was significantly higher than the $3.47 spent by households of children >5 years (p=0.01). (Table 4.6)

Table 4.6: Household costs by age categories

Cost Item	Household cost (US$) of treating SMA				
	<5yrs		≥5yrs		p-Value
	N	Mean (Range)	n	Mean (Range)	
Lab costs	23	6.35 (1.90-23.40)	40	5.77 (1.90-28.40)	0.65
Drug costs	139	5.83 (0.30-21.70)	55	11.09 (0.30-26.40)	**0.01**
Ward costs	152	11.24 (2.20-19.70)	61	12.77 (4.70-19.70)	**0.01**
Transport costs	202	2.28 (0.20-20.80)	68	2.47 (0.30-14.00)	0.55
Other costs	74	8.41 (1.24-14.70)	43	3.47 (0.74-14.70)	**0.01**
TOTAL	202	18.55 (1.50-65.38)	68	28.48 (1.20-70.52)	**0.01**

Table presenting Welch's t-test comparing the costs incurred by the households of children presenting to JOOTRH with SMA by age category. Table shows the number of children in each category, mean cost per cost item and the range (upper and lower limits), and a p-value after performing a Welch's t-test (Statskingdom.com).

4.7.2 Provider Costs

The health care provider also incurred costs to supplement those of the patients. The hospital partly catered for laboratory costs for 209 (77.1%) out of the 271 patients. This was an average expenditure of $6.27, ranging from $1.00 to $28.40. Of these 180 (86.1%) were children <5 years who incurred an average of $4.16, and 29 (13.9%) were >5 who spent an average of $6.61. The hospital spent significantly more money on laboratory costs for children >5 years compared to those younger (p=0.01).

The hospital also complimented drug costs for 216 (79.7%) children with an average of $9.32 which ranged from a minimum of $0.30 to a maximum of $22.60. This was made up of 184 (85.2%) children <5 years and 32 (14.8%) children >5 years, who spent a marginally low average of $9.49 compared to the younger age group who spent $9.29 (p=0.8).

Costs for staying in the ward were also incurred by the health provider for 207 (76.4%) children. For these children, an average amount of $5.38 was spent, and ranged from $0.50 to $14.38. The 207 children were made up of 180 (87%) <5 year-old children who spent an average of $5.41, and 27 (13%) >5 year-old children who spent an average of $5.19. This difference was not statistically significant (p=0.323).

The health provider also catered for other treatment-associated costs for 200 (73.8%) of the children, who spent an average of $1.94 per child. This expenditure ranged from a minimum of $o.16 to a maximum of $5.34. Out of the 200 children, majority were those below 5 year- 172 (86%), while 28 (14%) were 5 years and above. The younger children incurred a higher average cost of $1.97 while the older ones spent an average of $1.77 per child (p=0.18).

In summary, out of the 271 children recruited into this study, the health provider spent an average of $16.80 on each of the 221 (81.5%) children. This ranged from $0.16 to $49.76 per child. Of the 221 children, 186 (84.3%) were children below 5 years, forming the majority of children co-sponsored by the health provider, and who spent an average of $17.41 per child. Children >5 years were 35 (15.8%) and spent averagely $13.56 per child, less than what was spent by the younger children (p=0.005) (Table 4.7).

Table 4.7: Health Provider costs by age categories

Cost Item	Health provider cost (US$) of treating SMA				
	<5yrs		≥5yrs		p-Value
	N	Mean (Range)	n	Mean (Range)	
Lab costs	180	6.61 (1.00-28.40)	29	4.16 (1.90-6.90)	**0.01**
Drug costs	184	9.92 (0.30-19.20)	32	9.49 (0.30-22.60)	0.83
Ward costs	180	5.14 (0.50-14.38)	27	5.19 (5.00-10.00)	0.32
Other costs	172	1.97 (0.24-5.34)	28	1.77 (0.16-3.50)	0.18
TOTAL	186	17.41 (3.54-49.76)	35	13.56 (0.16-28.70)	**0.01**

Table presenting the costs incurred by the health provider for children presenting to JOOTRH with SMA by age category. Table shows the number of children in each category, mean cost per cost item and the range (upper and lower limits), and a p-value after performing a student t-test (Statskingdom.com).

4.7.3 Relationship between household costs and gender

The distribution of household costs by gender, differentiating between children < 5 years and those >5 years was evaluated. The Welch's t-test analysis was used to assess differences in means between expenditure by female and male SMA patients in treating SMA. Analysis was done differentiating the different cost items, laboratory costs, drug costs, ward costs and transport costs. In male children <5, the largest expenditure was on ward costs (mean $11.24, range $2.20-$19.70), while the lowest cost was on transport (mean $2.29, range $0.20-$20.80). In children <5 years, lab costs (p=0.82), drug costs (p=0.4), ward costs (p=0.57), transport costs (p=0.97) and other costs (0.45) were not statistically different between male and female children (Table 4.8a).

Similarly, for children >5 years, the largest expenditure was on ward costs (mean $14.15, range $7.20-$19.70), while the least cost contributor was transport (mean $2.69, range $0.50-$14.00). In this age group, similarly, lab costs (p=0.68), drug costs (p=0.98), ward costs (p=0.72),

transport costs (p=0.65) and other costs (0.81) were not statistically different between male and female children.(Table 4.8b).

In total, the household costs incurred by male versus female children <5 years, and male versus female children >5 years were not statistically significant (p=0.72, p=0.69 respectively).

Table 4.8: Household costs and gender

(a)

Cost Item	**Household cost (US$) of treating SMA in children <5 years**				
	Males		**Females**		**p-Value**
	n(%)	**Mean (Range)**	**n (%)**	**Mean (Range)**	
Lab costs	14 (11.0)	6.74 (1.90-23.40)	9 (11.8)	5.62 (3.90-6.90)	0.82
Drug costs	88 (69.3)	5.94 (0.30-21.70)	51 (67.1)	5.39 (0.35-15.00)	0.40
Ward costs	96 (75.6)	11.24 (2.20-19.70)	55 (72.4)	11.09 (4.70-19.70)	0.57
Transport costs	126 (99.2)	2.29 (0.20-20.80)	76(100.0)	2.29 (0.20-11.10)	0.97
Other costs	45 (35.4)	8.05 (1.24-14.70)	29 (38.2)	9.00 (1.58-14.70)	0.45
TOTAL	126 (99.2)	18.62(1.50-65.58)	76(100.00)	18.03(4.90-45.84)	0.72

Table showing Welch's t-test analysis to compare the difference between household costs incurred by female and male SMA patients aged <5 years. The table shows the number of children per gender in each cost item, the mean expenditure and ranges, and p-value from the t-test.

(b)

Cost Item	**Household cost (US$) of treating SMA in children >5 years**				
	Males		**Females**		**p-Value**
	n(%)	**Mean (Range)**	**n(%)**	**Mean (Range)**	
Lab costs	23 (57.5)	5.55 (2.90-17.30)	17 (60.7)	6.12 (1.90-28.40)	0.68
Drug costs	31 (77.5)	11.80 (0.60-26.40)	24 (85.7)	10.73 (2.80-18.10)	0.98
Ward costs	38 (95.0)	12.22 (4.70-24.70)	24 (85.7)	14.15 (7.20-19.70)	0.72
Transport costs	40 (100.0)	2.42 (0.30-10.50)	28(100.0)	2.69 (0.50-14.00)	0.65
Other costs	24 (60.0)	3.56 (0.74-14.70)	19 (67.9)	3.46 (1.16-14.70)	0.81
TOTAL	40(100.0)	28.51(1.20-67.54)	28(100.0)	30.07(6.08-70.52)	0.69

Table showing Welch's t-test analysis to compare the difference between household costs incurred by female and male SMA patients aged >5 years. The table shows the number of children per gender in each cost item, the mean expenditure and ranges, and p-value from the t-test.

4.7.4 Relationship between healthcare provider costs and gender

The distribution of healthcare costs by gender, differentiating between children < 5 years and those >5 years was assessed. The Welch's t-test analysis was used to assess differences in means between expenditure by female and male SMA patients in treating SMA. Analysis was done differentiating the different cost items, laboratory costs, drug costs, ward costs and transport costs. In male children <5, the largest healthcare provider expenditure was on drug costs (mean $9.06, range $0.30-$19.10) followed by lab costs (mean $6.65, range $1.90-$28.40), while the lowest cost was on other costs (mean $1.97, range $0.24-$4.54). In children <5 years, lab costs (p=0.93), drug costs (p=0.3), ward costs (p=0.58), and other costs (0.73) were not statistically different between male and female children (Table 4.9a).

Similarly, for children >5 years, the largest expenditure was on drug costs (mean $10.02, range $0.30-$20.00) followed by ward costs (mean $5.50, range $5.00-$10.00), while the least cost contributor was other costs (mean $1.88, range $0.66-$3.50). In this age group, similarly, lab costs (p=0.87), drug costs (p=0.86), ward costs (p=0.88), and other costs (0.79) were not statistically different between male and female children.(Table 4.9b).

In total, the household costs incurred by male versus female children <5 years, and male versus female children >5 years were not statistically significant (p=0.74, p=0.90 respectively).

Table 4.9: Healthcare provider costs and gender

(a)

Cost Item	Healthcare provider cost (US$) of treating SMA in children <5 years				
	Males		Females		p-value
	n(%)	Mean (Range)	n(%)	Mean (Range)	
Lab costs	113 (89.0)	6.65 (1.90-28.40)	68 (89.5)	6.52 (1.00-26.40)	0.93
Drug costs	114 (89.8)	9.06 (0.30-19.10)	69 (90.8)	9.75 (0.30-19.20)	0.30
Ward costs	113 (89.0)	5.47 (0.50-12.50)	67 (88.2)	5.31 (1.90-14.38)	0.58
Other costs	108 (85.0)	1.97 (0.24-4.54)	64 (84.2)	2.02 (0.74-5.34)	0.73
TOTAL	117 (92.1)	22.32 (5.00-54.76)	69 (90.8)	23.20 (5.00-47.54)	0.74

Table showing Welch's t-test analysis to compare the difference between costs incurred by the health provider for female versus male SMA patients below 5 years old. The table shows the number of children per gender in each cost item, the mean expenditure and ranges, and p-value from the t-test.

(b)

Cost Item	Healthcare provider cost (US$) of treating SMA in children >5 years				
	Males		Females		p-value
	n(%)	Mean (Range)	n(%)	Mean (Range)	
Lab costs	130 (62.2)	6.15 (1.90-28.40)	11 (39.3)	4.55 (1.90-6.90)	0.87
Drug costs	135 (62.5)	9.05 (0.30-22.60)	12 (42.9)	10.02 (0.30-20.00)	0.86
Ward costs	130 (62.8)	5.40 (0.50-12.50)	10 (35.7)	5.50 (5.00-10.00)	0.88
Other costs	126 (63.0)	1.97 (0.16-4.54)	10 (35.7)	1.88 (0.66-3.50)	0.79
TOTAL	139 (62.9)	16.39 (0.16-49.76)	13 (46.4)	18.77 (3.90-31.44)	0.90

Table showing Welch's t-test analysis to compare the difference between costs incurred by the health provider for female versus male SMA patients above 5 years old. The table shows the number of children per gender in each cost item, the mean expenditure and ranges, and p-value from the t-test.

4.8 Outcome of severe malarial anaemia in children <10 years

4.8.1 Outcome of severe malarial anaemia

Out of the 271 children admitted with SMA, only 4 had a fatal outcome. Of these, 3 (1.48% of the <5s and 1.11% of the total) were below 5 years, while 1 (1.47% of the >5s and 0.37% of the total) were aged above 5 years (Figure 4.4)

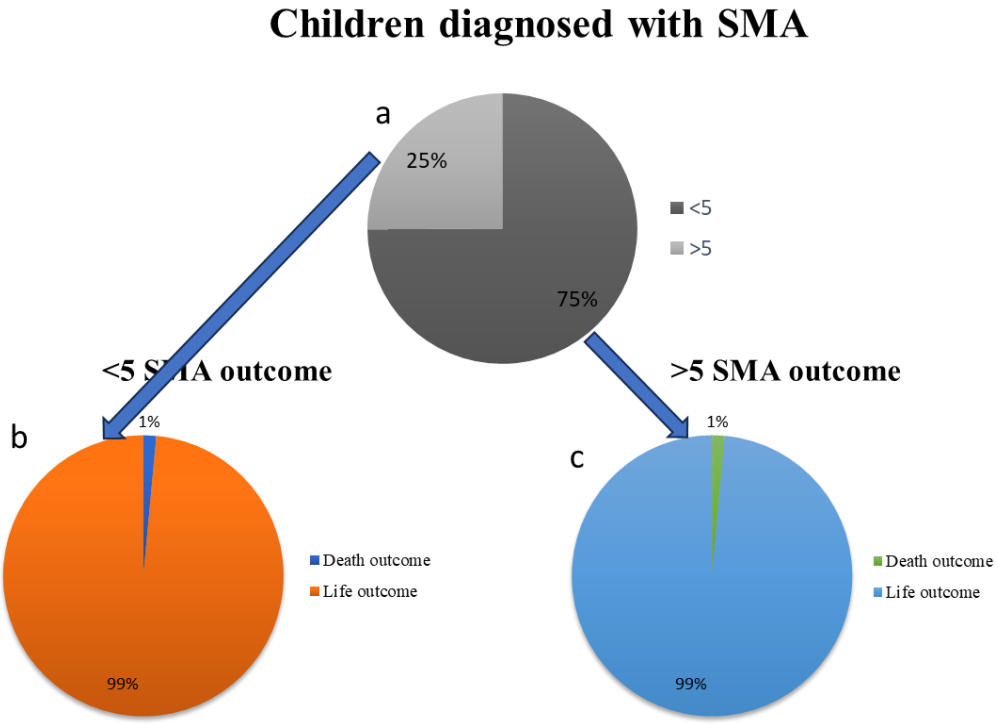

Figure 4.4: Pie charts showing the proportions of the SMA outcome of children <5 (b) and >5 (c) as proportions of the whole study population (a).

4.8.2 Influence of age on child's length of hospital admission

The mean number of admission days for children <5 years was 3.9 while it was 3.5 for those >5 years (Table 4.10).

A correlation analysis between the child's age and the days of admission for children <5years showed a negative correlation, meaning increase in age was correlated with lower number of days in hospital (p=0.05). For children >5 years, there was also a negative correlation between child's age and the days of admission, though this correlation was not statistically significant (p=0.698), Table 4.10

Table 4.10: Correlation between child's age and number of days of admission

		< 5 years		> 5 years	
		AGE	**Days of Admission**	**AGE**	**Days of Admission**
AGE	Pearson Correlation	1	-0.138	1	-0.048
	Sig. (2-tailed)		**0.05**		.698
	N	203	203	68	68
	Mean		3.9		3.5

Table showing the Pearson's correlation between the number of admission days for children <5 and those >5 years, and the children's age, and the mean number of days of admission for children <5 years and >5 years.

4.8.3 Influence of age on time taken before child's hospitalization

A correlation analysis between the child's age and the days taken before the caregiver sought intervention for children <5years showed a non-significant negative correlation, meaning increase in age was correlated with lower number of days in hospital (p=0,143). For children >5 years, there was also non-significant negative correlation between child's age and the days of admission, (p=0.869), Table 4.11.

Table 4. 11: Relationship between age of sick child and delay in admission

		<5 years		>5 years	
		AGE	**Days to Intervention**	**AGE**	**Days to Intervention**
AGE	Pearson	1	-0.103	1	-0.020
	Sig. (2-tailed)		0.143		0.869
	N	203	203	68	68
Days to Intervention	Pearson	-0.103	1	-0.020	1
	Sig. (2-tailed)	0.143		0.869	
	N	203	203	68	68

Table showing the Pearson's correlation between number of days taken to seek intervention for children <5 and those >5 years, and the number of days of admission.

4.8.4 Effect of the healthcare seeking behavior on the delay in admissions and length of hospitalization

The caregivers were interviewed on the healthcare seeking options they took. The study evaluated the effect of these options on the delay of admission and length of hospitalization. Buying drugs at nearby stores and giving them to the sick child did not cause a significant delay in taking them for admission for children <5 years and >5 years (p = 0.344, p=0.216 respectively). It was also not significantly associates with the time of admission for children<5 and >5 (p=0.430, p=0.093 respectively). Similarly, there was no relationship between use of herbs and delay in child admission for children <5 years and >5 years (p = 0.471, p=0.642 respectively). It also had no relationship with admission time for children <5 and >5 years (p=0.789, p=0.698 respectively). Consulting a community health worker did not significantly influence the delay in child admission for children <5 years and >5 years (p=0.618, p=0.306 respectively). It also did not influence the time of admission for children <5 and those >5 years (p=0.557, 0.480 respectively. Interestingly, giving remainder drugs to the sick child <5 years significantly increased the delay in taking them to hospital for admission (p = 0.011), but had no

significant influence for children >5 years (p=0.921). It also had no significant influence on the time of admission for children of both age groups (p=0.414, 0.258 respectively; (Table 4.12).

Table 4.12: Relationship between pre-hospitalization measures undertaken by the caregiver with the delay in admissions and length of hospitalization

Pre-hospitalization measures	Delay in admission p-value		Admission time p-value	
	<5 years	>5 years	<5 years	>5 years
Bought drugs	0.344	0.216	0.430	0.093
Visited a traditional healer	N/A	N/A	N/A	N/A
Used herbs	0.471	0.642	0.789	0.698
Community health worker	0.618	0.306	0.557	0.480
Used remainder drugs	**0.011**	0.921	0.414	0.258

Table showing the p-value of multinomial regression analysis of the delay in admission and pre-hospitalization measures taken by caregivers of children <5 years versus children >5 years.

4.8.5 Relationship between delayed hospital admission and length of hospitalization

In children <5 years, there was a slight positive correlation, though non-significant correlation between the duration taken by the caregiver to seek intervention and the length of hospitalization. The longer they took to take the sick child to hospital, the longer the hospitalization (Pearson's correlation, 0.006, p=0.934; Figure 4.5).

In children >5 years, there was a non-significant negative correlation between the duration taken by the caregiver to seek intervention and the length of hospitalization (Pearson's correlation, -0.1386, p=0.261; Figure 4.6).

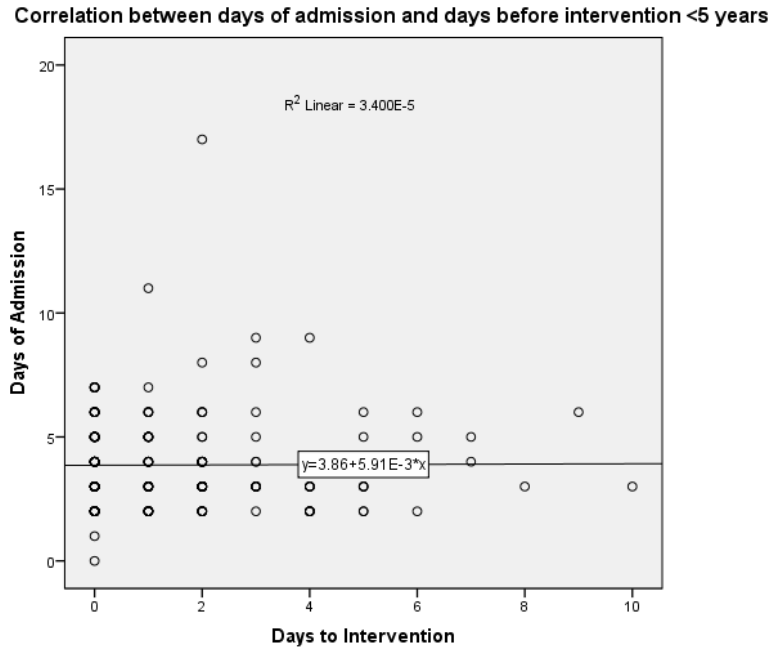

Figure 4.5: Relationship between delay in admission of the sick child and the length of hospitalization of children <5 years at the JOOTRH

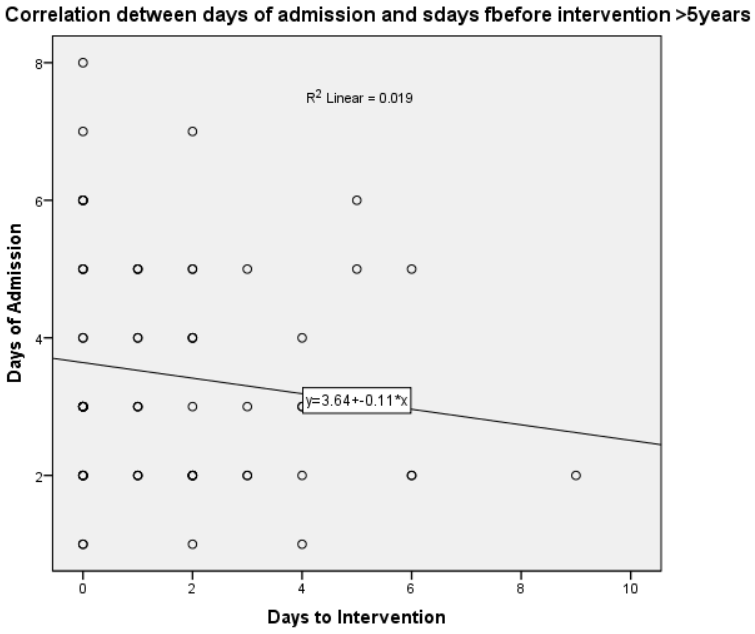

Figure 4.6: Relationship between delay in admission of the sick child and the length of hospitalization of children <5 years at the JOOTRH

CHAPTER FIVE

DISCUSSION

5.1 Severe malarial anaemia age trend in children <10years

This current study established that severe malarial anaemia was more common in children under the age of 5 years old as compared to children who were five years and above. It can therefore be concluded that no shift in age of children with SMA from <5 years to >5 to <10years was observed in the current population. Other studies have documented a possibility of a shift in age of severe malaria infected children from the younger to older children (Pemberton-Ross et al., 2015;(Bouyou-Akotet et al., 2009; Doolan et al., 2009) because of hampering of acquired immunity due to development and implementation of malaria control strategies. This however, that was not the case in the current study.

The current findings agree with a comprehensive search of 2 databases, Ovid MEDLINE and Embase, that found higher prevalence of SMA in children younger than 5 years, compared to those between 5 years and 15 years (Mousa et al., 2020). Another study reviewed hospital admissions of children with malaria aged between 3 months to 9 years from 2006 to 2020 in East Africa. The study showed that throughout this period, severe malaria mostly affected children below 5 years (Paton et al., 2021). These findings are also in convergence with earlier studies including by (Doolan et al., 2009), that adults and older children are able to control parasitaemia and therefore rarely suffer from severe malaria except for mild malaria symptoms. In the under-fives, studies have shown that SMA is more common in children under 3 years (Novelli et al., 2010; Obonyo et al., 2007; Oduro et al., 2007). This was also evident in this study as children under 3 years were 123 (70.7%) of the total under-fives who has SMA.

In a previous study (Fowkes et al., 2016), it was noted that in the low transmission areas, the older children would have equal chance of contracting malaria as the young ones, and the

explanation was that this is as a result of poorly developed immunity to malaria because of infrequent exposures thus making them vulnerable to severe clinical illness and complications from Plasmodium infection. Since western Kenya where the current study was carried out is a holoendemic region, the children who were five years and above had acquired immunity as a result of more frequent exposure to malaria as compared to the younger ones who were less than five years old.

The present study did not exhibit any shift in age of children with SMA from younger to older children. Possible explanations could be that even though there is use of malaria control strategies in this area, especially ITNs, as was found in a previous study, there may be reduced efficacy of ITNs, due to insecticide resistance in mosquitoes and lack of proper use of ITNs (Lindsay et al., 2021), thus the children are still exposed to many infectious bites. The other possible explanations could be Insecticide-treated bed nets reduce malaria transmission by limiting contact between mosquito vectors and human hosts when mosquitoes feed during the night, however, malaria vectors can also feed in the early evening and in the morning when people are not protected. It will therefore be of great interest to continue monitoring the trend as the current existing malaria prevention methods targeting the <5years are continuously being enhanced and also with the planned introduction (currently in pilot phase) of the malaria vaccine which will target children up to 2 years of age.

5.2 Caregiver's knowledge on the recognition of SMA in children <10years

According to Integrated Management of Childhood Illness (IMCI) guidelines, general danger signs of under-five childhood illnesses are categorized as: unable to breastfeed, unable to drink or eat, vomiting everything, convulsion and lethargy/unconscious. IMCI guidelines under

community component is to improve knowledge and practices of caregivers in community through community promoters (WHO.,2017).

The knowledge of caregivers of children <5 years on the signs of severe malarial anaemia using the IMCI guidelines on general danger signs was found to be wanting as demonstrated by the fact that majority did not recognize the danger signs which is a crucial factor that will affect the care-seeking behavior by the caregivers. This was the same for children 5 years to <10 years, however it is still not yet clear if the general danger signs also applies to children >5years to <10 years as the current guidelines is specifically for <5years.

This is unlike the North East Tanzanian study by (Ringsted et al., 2006), where the caregivers were able to recognize general symptoms that indicated emerging or present low hemoglobin (Hb). Some of the symptoms they were able to recognize included lethargy, unable to sit or be carried on mothers back, sleeping all the time and convulsions. The study, however, focused on children who were below 2 years of age. The findings in the current study support observations in a systematic review done by a group (Geldsetzer et al., 2014), that indicated that caregiver's ability to recognize severe disease is generally poor and represents a key factor to address in attempts to improve health care utilization. Reductions in morbidity and or mortality require greater emphasis on recognizing of danger signs at home and prompter care-seeking. The role of CHVs and CHEWs in delivering information and healthcare to rural populations, some of which are represented by the population of patients attending JOOTRH should be included in the integrated malaria management programs to ensure better knowledge and the ability to recognize malaria symptoms in children below 10 years. This knowledge will contribute to faster health seeking actions, that eventually lead to better medical outcomes for the malaria patients.

The caregiver's knowledge on identification of pallor from different anatomical sites for both < 5 years and >5 to <10 years was also wanting. This is specifically important for children with SMA.

The findings in a previous study (Sumbele et al., 2013) in Cameroon region, are in concurrence with the findings in the current study whereby majority of the caregivers were unable to recognize paleness of the conjunctiva and palms, which were more apparent in children who had severe anaemia. However a study in Asembo Bay in western Kenya (Desai et al., 2002) revealed that the caregivers could recognize severe anaemia (Hb<5.0g/dl, using pallor at different anatomical sites, albeit with moderate accuracy). In this study, unlike the current study, the caregivers had received some training in identifying pallor and the different anatomical sites used for identifying palor prior to collecting information which might have influenced the test characteristic.

Study by (Maduka et al., 2019) also found out that with a home –based anaemia screen tool, caregivers are able to identify severe anaemia from the different anatomical sites unlike those without the anemia screen tool.

Even though identification of pallor from various parts of the body is primarily used by health care workers, the caregivers' knowledge of this is also very important as it can assist the caregivers make informed decisions on taking the child to a health facility and even to a larger extent to a facility where transfusion services are available, so as to cut short the time usually taken when they go to a facility without transfusion services then have to be referred. The current study did not provide any training to the caregivers on how to identify pallor from different anatomical sites nor did it ask the caregivers if they have received such training from any other

source, but the findings as compared to those who received training or a guide on how to I identify severe anaemia indicate probably that they have not received any training. The role of Community Health Education Workers (CHEWs) and Community Health Volunteers (CHVs) in the community, in addition to in-hospital education of caregivers in recognizing pallor for identification of anaemia is critical to improve the child's heath outcome upon timely treatment.

5.3 Health care seeking behavior among caregivers of the children <10 years with SMA

A number of caregivers gave some remainder drugs before presenting to a health facility. More children under 5 were administered with remainder drugs compared to children over 5 years (39% vs 31%). The difference in the admission duration for children under five caregivers who used remainder drugs was statistically significant. This implies that caregivers have mini-drug stores in their houses. Younger children being administered with remainder drugs is wanting. The caregivers could have felt a sense of urgency for younger children compared to older ones, thus resorting to giving the nearest available remedy, which are drugs left over in the house. The drugs they had may have been for treating this child's previous ailment or for treating another family member, and which raises a number of questions, why they did not finish the dose, under what conditions the drugs were stored, what was the expiry date and whether or not they checked that before administering the drug, and what dose of the drug was given. These are fundamental drug administration issues that can affect the outcome of a disease.

A study done in northern Ethiopia revealed that most drugs kept at home were not appropriately labeled and stored in a safe place (Wondimu et al., 2015). The current study did not find out how the labeling was done and under what storage conditions the medicines were kept, but there could be adverse outcomes if the findings in Northern Ethiopia were the same in this area. Some caregivers gave painkillers, anti-malarial and antibiotics. The source of these drugs was not

established in this study, but the drugs that the caregivers had at home and gave the children may have come from initial excessive prescribing for treatment, inadequate adherence to treatment and anticipated future use as was found in a study in Iraq (Jassim, 2010).

As in other studies (Chipwaza et al., 2014a; Watsierah et al., 2011), caregivers could effectively name the anti-malarial drug they gave. ACT was the drug commonly used by the caregivers.
The caregivers who gave pain killers risked masking the ongoing disease process. Pain killers relieve symptoms that can make a caregiver not take her child to the hospital immediately thinking that they are improving but the disease condition is progressing. The malaria drugs were also given without malaria confirmatory tests as is globally recommended (World Health Organization, 2011).

A good number also bought drugs at drug stores/pharmacies. This was the most common approach for children older than 5 years, compared to their younger counterparts. As inferred above, this could be because older children ailment may be considered less urgent compared to younger children, therefore the caregivers had time to make the decision to buy medication from a nearby pharmacy. Previous studies (Horton & Stewart, 2012; Hughes et al., 2000), have reported that the common reasons for self-medication were shortages of drugs at health facilities, long waiting time at health facilities, long distance to health facilities, inability to pay for health care charges and the freedom to choose the preferred drugs. These may have also been the contributory reasons in this study.

Consulting with community health workers was the third most used health seeking behavior among those tested in this study, both for <5s and >5s. Caregivers of children >5 were however, more frequently taken to CHWs compared to those <5 in the current study. The lower utilization

of CHWs as a health seeking behaviour in the current study could be attributed to the mixed backgrounds of patients attending JOOTRH, which comprises both modern and rural communities. CHWs are mostly useful in rural communities compared to urban communities as evidenced by (Druetz et al., 2015). A study in Madagascar showed that CHVs were the second most care sought for by caregivers for children with malaria and pneumonia (Sayre et al., 2021). A previous study in Kenya showed that the uptake of CHWs in coastal Kenya was aimed at improving access to malaria treatment and increased the more caregivers were aware about their contribution to malaria control (Kisia et al., 2012). On the other hand, a study based in DRC found that receiving information from CHWs did not determine the knowledge of antimalarial use or adequate health seeking and behaviour, therefore not useful in determining the health outcome of children with malaria (Ntamabyaliro et al., 2021). Another possible explanation for the lower uptake of CHWs as a first response to healthcare seeking is the inaccessibility of the CHWs. In case the participants do not have the CHWs contacts, or live far from where the CHWs are based, it would be an easier and faster decision for caregivers to seek help from remainder drugs in the house of rush to the nearest pharmacy or store to buy drugs to alleviate the child's symptoms. A WHO report on the role of CHWs in HIV, TB and malaria programs highlighted that the major challenges of community health programs included accessibility, availability, and acceptability of CHWs by the community (World Health Organization et al., 2019). An analysis of the evolution of CHWs in India also highlighted accessibility as a major issue to be dealt with to increase the uptake of CHWs as a first line healthcare provider (Mor et al., 2023). To discourage self-medication in caregivers of children with malaria, policy makers should consider accessibility of CHWs and an urgent concern to improve healthcare.

None of the caregivers in the current study reported visiting a traditional healer. Other studies have reported low use of traditional healers as it is at times associated with stigma hence those using them may not openly declare so (Pariyo et al., 2009). It could not be established in the current study if this was the case with the current study population. Other findings in the current study demonstrated that a minority of the caregivers used herbs (10%). Herbal medicines can cause kidney failure and liver damage because they contain toxic chemicals or heavy metals, or react harmfully with other drugs (Ekor, 2014). The medication regimen have not been documented and scientifically evaluated to determine their efficacy and dosage vis-à-vis the alleged indications (Ekor, 2014). From the experiences when working at the pediatric emergency care room, children who had history of having taken herbs and presenting with severe disease always had adverse outcomes as compared to children with severe disease with no history of having have taken herbs.

There were no statistically significant differences between most of the pre-hospitalization measures taken by the caregivers with regard to patient's gender and age, and caregiver's level of education. This was a little bit different from the finding in a study done in rural Tanzania (Kanté et al., 2015) that revealed that the younger the child, the likelihood that care will be sought from a health facility immediately. The study, however, was comparing the health-seeking behavior in children who were under 5 years old only, whereby those below one year, care was sort more from a health facility.

There was no significant difference in the delay of child admission at JOOTRH between caregivers who had primary education only and those with a minimum of secondary education. This was an interesting finding as it differs with other studies that have indicated that parents who took their children earlier to the hospital had more education than parents who took longer

(Asfaw et al., 2018; Pajuelo et al., 2018). The difference could be explained by the fact that the current study did not have illiterate participants. Most of the mothers were young and currently the government has been investing in education access to all Kenyans (Somerset, 2009).

5.4 The economic burden of severe malarial in children<10years

When Free treatment policy for malaria in children <5years was introduced in Kenya in the year 2005, it was expected that such a shift would improve financial access to treatment by the poorest patients, but households frequently pay for hospital stay and/or drugs and supplies (henceforth all termed 'user fees'). The current study revealed that caregivers of children < 5 years still incur costs on management of their children with SMA. The mean household cost for children <5yrs was USD 18.55. This is different from the study by (Alonso et al., 2019) in Mozambique, which showed the median household cost for <5 years to be USD 69.90 for severe malaria. Just as it is in Kenya, the Mozambican Ministry of Health provides free diagnosis and treatment for malaria for <5 years at public health facilities. The cost in the Mozambique study could have been higher because it included cost due to lost wages by the caregivers who were taking care of the child. The costs involved were also not just for children with SMA, but included children with other forms of severe malaria like celebral malaria.

The study by (Caroline et al., 2021) in Kenya revealed that the mean total household cost per patient was USD 16.4. This is closer to the current study that found the mean household cost for children <5yrs to be USD 18.55. This study however deferred from the current study in that it enrolled infants, children, adolescents and adults admitted to hospital with a diagnosis of malaria, associated symptoms such as fever, malaise, headache or vomiting and a laboratory confirmed Plasmodium-positive blood smear. It also enrolled patients with malaria and other

comorbidities. Enrollment of patients admitted with malaria but nor severe malaria may have caused the slightly lower cost in this study.

It would then be expected that children <5 years would not incur any costs on drugs and laboratory tests as these are paid for by the government. It was found, however, that sometimes the hospital lacked malaria drugs or other laboratory consumables needed for SMA treatment, thus making the parents/guardians of the under-fives to buy or pay for the service. The indirect costs involved in the management of SMA for <5 yearsalso causes burden to the households. These include, registration fees, buying of a file, bed / laundry fees and transport thus should be considered in the government subsidies.

The mean household costs for treating children >5 years and <10 years was USD 28.28 which was significantly higher than those for <5 years. This is because direct costs in management of SMA a for <5years are paid for by the heath provider through the government subsidies unlike for >5years and <10years. The study by (Caroline et al., 2021) included children >5years and found the mean total household cost per patient as USD 16.4. This study however differed from the current one in that it included adolescents and adults, and also even though it was hospital based and all had malaria, not included in the study had severe malaria. A hospital based study by (Kodhiambo et al., 2020) which differed slightly with the current study in that it enrolled children<13years, with paediatric malaria revealed that the total household costs were, USD 20.63 at level IV hospital. The study however included all types of severe malaria and not just SMA. This may have cause the lower cost as compared to the current study. Management of non –severe malaria admission presumable is cheaper than management of severe malaria.

Breaking into individual cost items, the cost of drugs, ward services and transport significantly contributed to the higher total costs for older children. This could be because older children will generally require higher doses of medicine and ward consumables for their treatment. Caregivers also spend more money on transport since they might be required to pay individual fares alongside their child if they are too old to be carried on the caregiver's laps.

The mean heath provider cost for treating a child < 5years with SMA was higher than for that for >5 years to >10 years because the hospital meets these costs through the government organized subsidies programme.

The study by (Alonso et al., 2019) revealed that the median health system costs associated with malaria among patients of all ages was USD 26.56 per severe case unlike the current study that was USD 17.41 for <5years and USD 13.56 for >5years to < 10years for SMA. The difference in costs could be as a result of inclusion of all forms of severe malaria like celebral malaria and also the enrollment of all age groups in the study.

The mean health system cost per patient was USD 42.0 in a study by (Caroline et al., 2021). This is high compared to the current study for the < 5years and >5years to <10 year. The study unlike the current study enrolled children with malaria and comorbidities. The results from the same study revealed that comparing patients with no comorbidities to patients experiencing one or more comorbidities, for patients with comorbidities the mean health system costs per patient increased by 43%. This may explain the high cost compared to the current study. The study also enrolled different age groups.

5.5 Outcome of severe malarial anaemia in children <10 years

Fatalities were only realized in 4 children. However, the percentage of death outcomes in both the <5 group and the >5 group was the same. This suggests that by and large, the care that is

provided in the hospital is effective and saves lives. It may also be attributed to the availability of screened blood in the hospital. However, the chances of children dying from SMA from both age groups in the current study was the same. This finding is contrary to others that have shown that younger children aged 5 years and below with severe malaria are more likely to have a death outcome than older children (Maitland, 2016). For instance, a study surveying death from malaria among travelers showed that younger children and senior citizens were more likely to die from malaria (Lüthi & Schlagenhauf, 2015).

The study showed that the mean number of admission days for children below 5 years was 3.9 days while the mean for those above 5 years was 3.5 days. A study in Malawian children found out that the sickest patients had a short length of stay terminating in death, with highest risk of dying in hospital the same day of admission, however, as days of stay increased the risk diminished, only to increase again at day 7 (Kazembe et al., 2006). This is evident also in this study as the mean days of stay in the hospital was 3.9 for < 5 and 3.9 for >5 thus the high positive outcome rate in the study.

A correlation analysis showed a negative and significant correlation between age and days of admission in children <5 years. This meant that as the child's age increased, they spent less days in the hospital. The correlation was also negative for children >5 years, though not significant. This could be explained by the fact that older children are able to clear parasitaemia faster than the younger ones (White, 2017). The age of the child was also negatively correlated with the amount of time spent by the caregiver before admitting them to hospital, for both children < 5 years and >5 years. This correlation was, however, not statistically significant. The lack of significant association of delay in hospital admission and age was observed in a study in Equatorial Guinea that sought to assess the determinants of delay in seeking malaria treatment

for children that evaluated children aged 15 years and below (Romay-Barja et al., 2016). This study, however, did not assess any differences in age groups. In contrast, a study in Tanzania found that age was a significant determinant of delay in hospital admission (Kassile et al., 2014). Buying drugs at nearby stores and giving them to the sick child did not cause a significant delay in taking them for admission for children >5 years. It however, had a significant effect delay in admission for children <5 years. This could be due to the quick response that children <5 could have to anti-inflammatory drugs, that will see them bounce back from fever, chills and fatigue and get back to high energy and playfulness. The study found that paracetamol, an analgesic and anti-inflammatory drug, was the most administered drug in the current study. Buying drugs did not have a significant influence on the time of admission for both children <5 and >5 years in the current study. Self-medication was established as a common practice among caregivers of children < 10 years diagnosed with malaria in Dodoma, Tanzania (Chipwaza et al., 2014b). Caregivers reported that they would only visit the health facility of there was no improvement of the child's symptoms, or if they got worse. The study did not however assess any age-group differences.

In the current study, consulting a healthcare worker did not play a role in the delay in hospitalization or length of hospitalization in children <5 and >5 years. Community health workers who are the frontline health workers play a pivotal role in promoting health care access (Hartzler et al., 2018). Consulting them is expected to play a key role on proper referral of the children. Community health workers have necessary medical training, and are aware of recognizing malaria symptoms, and providing valuable advice to the caregiver regarding the best medical steps, usually providing first line medication, then referring the patients to hospital.

However, JOOTRH having a combination of rural and urban patients, urban patients have less uptake of CHW services, which could explain the current trend (Druetz et al., 2015).

A review of studies focused on progression into severe malaria showed that the odds of any severe malaria phenotype were significantly higher in children with longer delays between initial symptoms and arrival at the health (Mousa et al., 2020). There was a positive correlation between the duration taken by the parent/guardian to make the decision of presenting the sick child to hospital and the length of hospitalization. The longer they took to take the sick child to hospital, the longer the hospitalization. This can be explained by the fact that delay caused in seeking proper medical care leads to illness progression to more severe stages consequently resulting in a heightened need for more medical care (Getahun, 2010).

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

6.1.1 Severe malarial anaemia age trend in children <10years

In the current study, SMA cases were more common in children under the age of 5 years old as compared to children who were >5 to < 10 years and above based on the children who presented at, and were diagnosed at JOOTRH. It can be inferred that current development and implementation of malaria control has not led to a shift in age of severe malaria infected children from the younger to older children. However, it will be important to continue monitoring the trend as the current existing malaria prevention methods targeting the under 5 are continuously being enhanced and also with the planned introduction of the malaria vaccine which will target children up to 2 years of age, acquired immunity in younger children could be delayed further.

6.1.2 Caregiver's knowledge on the recognition of SMA in children <10years

Caregiver's ability to recognize SMA is generally wanting, as supported by other studies considering this knowledge requires training. This finding represents a key factor to address in attempts to improve health care utilization. The knowledge level was similar for children <5 years and >5 to <10 years. Weak body and poor feeding were the most commonly recognized symptoms in children <5 and >5 to <10 years. The mixed urban and rural population of patients attending JOOTRH could have contributed to the low knowledge level because urban settings rarely interact with CHWs who play a major role in educating caregivers in recognition of malaria symptoms. Majority of the caregivers of children <5 and >5 to <10 years were unable recognize paleness which is more apparent in children who have severe malarial anaemia.

6.1.3 Health care seeking behavior among caregivers of the children <10 years with SMA

The current study found that most caregivers administered remainder drugs to sick children before they were taken to hospital. This trend was more common for caregivers of children <5 years. For children >5 to <10 years, most caregivers bought drugs from a nearby pharmacy before taking them to hospital. There could be a sense of urgency for caregivers of children <5 causing them to seek the nearest remedy, which is left over drugs. CHWs were not visited as often as using remainder drugs or buying drugs from a nearby store for both age groups. Having a mixed urban and rural population could contribute to the lower popularity of CHWs by caregivers from urban settings. CHWs could also be less accessible compared to readily available drugs at home or at a nearby pharmacy. It is important for policy makers to be aware of self-medication tendencies to define the best strategy to discourage the practice and encourage CHW and health facility visits instead.

6.1.4 The economic burden of severe malarial in children<10years

The mean total cost of SMA treatment is the same for children under-fives and>5 to <10 years. The difference is who incurs the highest costs. The provider bears the highest cost for the under-fives because the Kenyan government provides free treatment for children <5 years, shifting the greater cost burden to the health facility. On the other hand, the households incur the highest cost for>5 to <10 years because they bare all the direct and indirect cost involved in the SMA management. The older children mayalso incur the cost of transport if they cannot be carried on the mother's laps, and require higher doses of medication which utilize more money. Even though treatment of malaria for the under –fives is considered free, the households still incur costs in the management of SMA.

6.1.5 Outcome of severe malarial anaemia in children <10 years

The current study showed equal percentages of children died from SMA in both age groups, <5 years and >5 to <10 years'. In children <5 years old, the child's age was a significant determinant of the number of days they spent in hospital. However, age was not an influencer of length of admission in children >5 to <10 years'. For both age groups, age was not a determinant of delay in admission. The current study also showed that in children <5 years, using remainder drugs was the only pre-hospitalization action that significantly influenced delay in admission. Prognosis of severe malarial anaemia is good with timely blood transfusion and correct anti-malarial treatment.

6.2 Recommendations from current study

6.2.1 Severe malarial anaemia age trend in children <10years

Severe malaria anaemia is still more common in children under five years. More interventions still need to be geared to this age group and at the same time, there is need for complementary interventions targeted specifically to those age-groups at risk of burden shift as more interventions continue to evolve and especially with the planned roll out of the malaria vaccine.

6.2.2 Caregiver's knowledge on the recognition of SMA in children <10years

Proper health education should be given to the caregivers on a regular basis by the government by adopting an educational attitude. This aspect is of particular importance with respect to training the caregivers on how to recognize early danger signs of illnesses, in this case SMA. Caregivers of children <5 and >5 years equally need necessary training to properly recognize severemalaria symptoms, especially pallor for severe malarial anemia. Equal training opportunities should be given to caregivers from urban and rural areas. CHWs could be more

effective for the rural population, therefore in-hospital training, or the use of TV and radio broadcasts can be promoted for the urban populations.

6.2.3 Health care seeking behavior among caregivers of the children <10 years with SMA

There is need for community awareness for correct and comprehensive information about drawbacks associated with self-medication practices, which are similar for children<5 and >5 to <10 years who mostly use remainder drugs or buy drugs from a nearby store. Deliberate efforts by the government and other stakeholders to improve health care services, particularly at primary health care facilities will help to reduce self-medication practices. Since safety continues to be a major issue with the use of herbal remedies, it becomes imperative, therefore, that relevant regulatory authorities put in place appropriate measures to protect public health by ensuring that all herbal medicines are safe and of suitable quality. This study explores the requirements of a successful home management strategy.

6.2.4 The economic burden of severe malarial in children<10years

The government together with the hospital should ensure that all the drugs, blood and laboratory tests needed for management of malaria and its complications are always available especially for < 5 years since it's supposed to be free. The government should consider subsidies for children in the older age group to allow equal chances of accessing necessary healthcare.

6.2.5 Outcome of severe malarial anaemia in children <10 years

Considering the current study found that children <5 years and >5 to 10 years have an equal chance of mortality due to SMA, there needs to be more interventions to raise the awareness for early care-seeking during episodes' sick child in order to reduce the morbidity and mortality. Education efforts need to be concentrated on caregivers who self-prescribe possibly wrong medication, use herbal treatment for sick children, which could worsen the child's health outcome.

6.3 Recommendations for future studies

i. To continue monitoring SMA occurrence age patterns as malarial strategies continue to evolve.

ii. To collect household-related data directly from the household by way of physical visit to the patients' residence. To find out the about the drugs caregivers keep at home, to include where they came from, their labeling, presence of expiry dates, storage conditions and how they determine doses to give the children

iii. A retrospective study analysis of all children who have been reported to have died as a result of SMA to determine the age patterns, the caregiver's knowledge on recognition of severe anaemia and their health seeking behavior during the duration of the sickness so as to establish the likelihood predictors of death in children with SMA.

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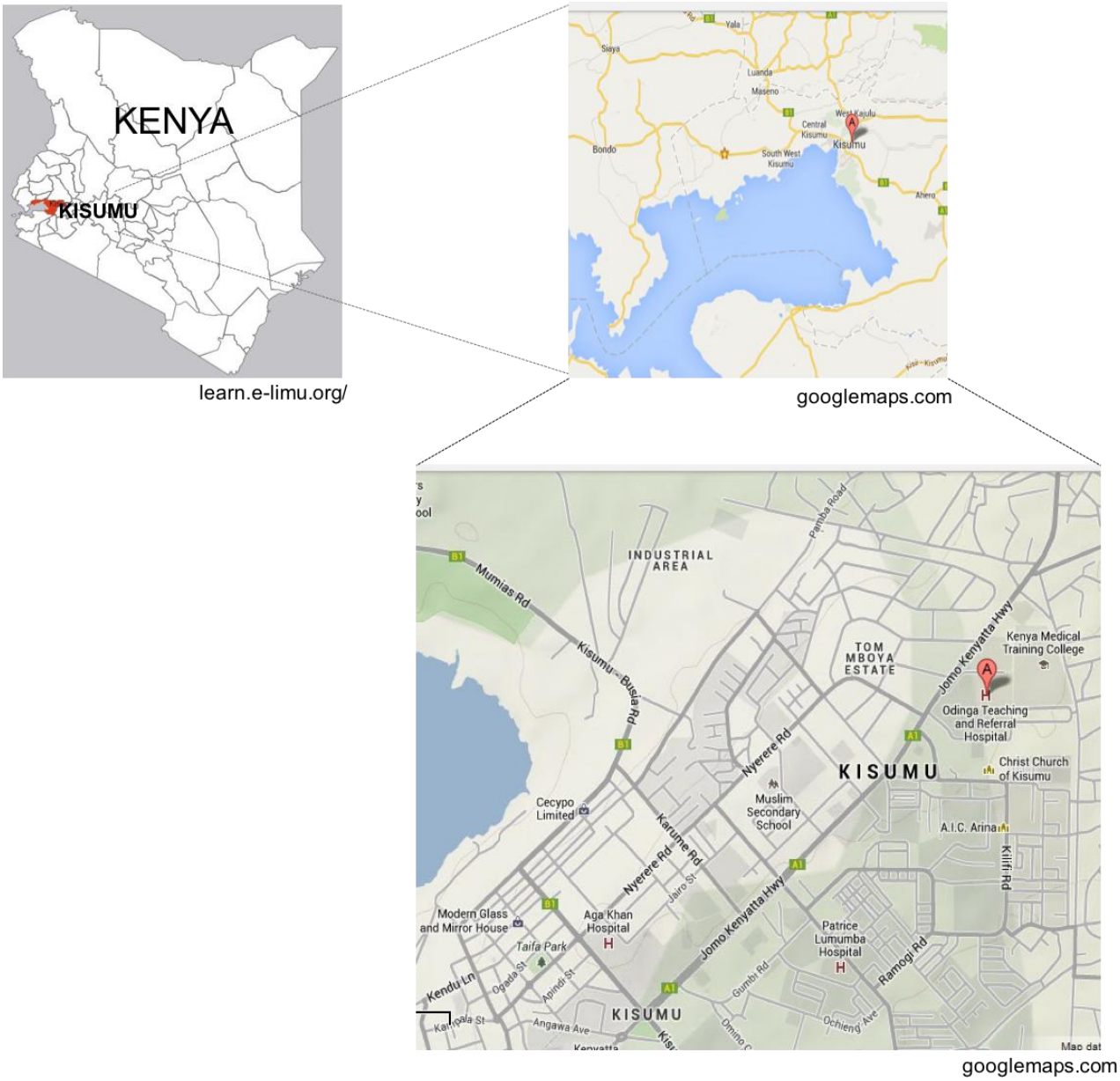
APPENDICES

Appendix 1: Map of the study site (JOOTRH in Kisumu, Kenya)



Appendix 2: Questionnaire

QUESTIONNAIRE

SECTION 1: DERMOGRAPHICS

Demographics of Child

Name_____

Date of birth _____ _____ _____

DD MMM YYYY

Age _____ Sex _____-

Demographics of caretaker

Name_____

Relationship to child_____

Age_____

Level of education_____

SECTION 2: ADMISSION INFORMATION

Date of admission _____

Vital signs at admission

Temperature _____Respiratory rate_____

Blood Pressure Weight

SECTION 3: INCLUSION CRITERIA

1) Is the child positive for malaria test? ☐ YES ☐ NO
2) Does the child have HB of < 5g/dl? ☐ YES ☐ NO
3) Is the child a known sickler? ☐ YES ☐ NO

Has the child met all the eligibility criteria? ☐ YES ☐ NO

SECTION 4: MALARIA CONTROL

BEDNET

1) For the last one year, how often has your child been sleeping under a mosquito net?

☐ Always ☐ At times ☐ Never

☐ Other Specify _____

2) Is the net a treated net or a non treated net ☐ Treated ☐ Not treated ☐ Unknown

3) The night prior to admission, did the child sleep under a mosquito net?

☐ YES ☐ NO

4) Where did your household get the net that the child has been using?

☐ Government campaign

☐ Community health worker

☐ Retail shop

☐ Agent/NGO

☐ Not sure

☐ N/A

☐ Other specify_____

INDOOR RESIDUAL SPRAYING

1) At any time in the past 12 months, has anyone come into your dwelling to spray the inside walls against mosquito to control malaria?

   ☐ YES ☐ NO

2) If yes how many months ago was the house sprayed? ☐☐

3) Who sprayed the house?

   ☐ Government Program me/worker

   ☐ Private company

   ☐ Household member

   ☐ Don't know

   ☐ Other, specify_____

ACTs

1) Prior to this admission, has your child been diagnosed to have malaria in the last 6 months?

☐ YES ☐ NO

2) Where was the diagnosis made?

☐ Government health facility ☐ Private hospital ☐ CHW ☐ other specify_____

3) Was a malaria test done?

☐ YES ☐ NO

4) Did you pay for the test?

☐ YES ☐ NO

5) Were you given drugs for malaria?

☐ YES ☐ NO

6) Did you pay for the drugs?

☐ YES ☐ NO

COMPLETE AT DICHARGE

OUTCOME

Discharge☐ YES Date_____

Death ☐ YES Date_____

Was the child transfused ☐YES ☐NO

If yes, did the hospital provide blood or you had to look for a donor

☐ Hospital Provided

☐ Looked for donor

What was the HB at discharge? _____

In the opinion of the managing doctor, was malaria the sole or major contributing factor to the severe anaemia? ☐ YES ☐ NO

If No, explain_____

SECTION: 5 ECONOMIC BURDEN OF MALARIA

5.1 HOUSEHOLD

HOUSEHOLD LABORATORY EXPENSES

DAY	TEST	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

HOUSEHOLD DRUGS EXPENSES

DAY	DRUG	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

HOUSEHOLD WARD EXPENSES

DAY	ITEM	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

HOUSEHOLD TRANSPORT EXPENSES

DAY	TRANSPORT	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

HOUSEHOLD OTHER EXPENSES

DAY	ITEM	COST
Day 1		
Day 2		

Day 3		
Day 4		
Day 5		

5.2 PROVIDER

PROVIDER LABOURATORY EXPENSES

DAY	TEST	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

PROVIDER DRUGS EXPENSES

DAY	DRUG	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

PROVIDER WARD EXPENSES

DAY	ITEM	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

PROVIDER OTHER EXPENSES

DAY	OTHER	COST
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		

SECTION: 6 KNOWLEDGE ON RECOGNITION OF SEVERE ANAEMIA

What would you expect to see if your child has severe anaemia?

(Check all the responses given).

History

Weak Body☐

Poor feeding☐

Eating Soil☐

Difficulty in breathing ☐

Unable to sit or drink☐

Other☐

If other please specify _____`_____

Physical Exam

Pale Skin☐

Palm Pallor☐

Nail Pallor☐

Eye lid pallor☐

Tongue pallor ☐

Appendix 3: School of Graduate Studies Approval

MASENO UNIVERSITY

SCHOOL OF GRADUATE STUDIES

Office of the Dean

Our Ref: PG/PHD/00112/2012

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 14th May, 2014

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR STACEY MAUREEN OKALLO GONDI—PG/PHD/00112/2012

The above named is registered in the Doctor of Philosophy in Public Health of the School of Public Health and Community Development, Maseno University. This is to confirm that her research proposal titled "The Effect of Implementation of Malaria Control Strategies on Severe Malarial Anaemia and its Implications in Children under 10 Years Old in Western Kenya" has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

MASENO UNIVERSITY DIRECTOR 16 MAY 2014 SCHOOL OF GRADUATE STUDIES

Dr. Pauline Andang'o
ASSOCIATE DEAN, SCHOOL OF GRADUATE STUDIES

Appendix 4: Maseno University Ethical Review Committee approval

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221
Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

FROM: SECRETARY - MUERC **DATE**: 10th July, 2014

TO: Stacey Maureen Okallo Gondi **REF**: MSU/DRPC/MUERC/000079/14
PG/MPH/00112/2012
School of Public Health and Community Development
Maseno University, Maseno, Kenya

RE: The Effects of Implementation of Malaria Control Strategies on the Occurrence of Severe Malarial Anaemia in Children Under 10 Years in Western Kenya. PROPOSAL REFERENCE NO: MSU/DRPC/ MUERC/000079/14

This is to inform you that the Maseno University Ethics Review Committee (MUERC) determined that the ethics issues raised at the initial review were adequately addressed in the revised proposal. Consequently, the study is granted approval for implementation effective this 10th day of July, 2014 for a period of one (1) year.

Please note that authorization to conduct this study will automatically expire on 9th July, 2015. If you plan to continue with the study beyond this date, please submit an application for continuation approval to MUERC Secretariat by 8th June, 2015.

Approval for continuation of the study will be subject to successful submission of an annual progress report that is to reach MUERC Secretariat by 8th June, 2015.

Please note that any unanticipated problems resulting from the conduct of this study must be reported to MUERC. You are required to submit any proposed changes to this study to MUERC for review and approval prior to initiation. Please advice MUERC when the study is completed or discontinued.

Thank you.

Yours faithfully,

Dr. Bonuke Anyona,
Secretary,
Maseno University Ethics Review Committee.

Cc: Chairman,
Maseno University Ethics Review Committee.

MASENO UNIVERSITY IS ISO 9001:2008 CERTIFIED

Appendix 5: Jaramogi Oginga Odinga Teaching and Referral Hospital Ethical Review committee approval

MINISTRY OF HEALTH

Telegrams: "MEDICAL", Kisumu
Telephone: 057-2020801/2020803/2020321
Fax: 057-2024337
E-mail: ercjootrh@gmail.com
When replying please quote

JARAMOGI OGINGA ODINGA TEACHING & REFERRAL HOSPITAL
P.O. BOX 849
KISUMU

Ref: ERC.1B/VOL.I/126

Date 4th September, 2014

Stacey Maureen Okallo Gondi,
MASENO UNIVERSITY.

Dear Stacy,

RE: FORMAL APPROVAL TO CONDUCT RESEARCH TITLED: *"EFFECT OF IMPLEMENTATION OF MALARIA CONTROL STRATEGIES ON SEVERE MALARIAL ANAEMIA AND ITS IMPLICATIONS IN CHILDREN 10 YEARS OLD AND BELOW IN WESTERN KENYA"*

The JOOTRH ERC (ACCREDITATION NO. 01713) has reviewed your protocol and found it ethically satisfactory. You are, therefore, permitted to commence your study immediately. Note that this approval is granted for a period of one year (4th September, 2014 to 4th September, 2015). If it is necessary to proceed with this research beyond the approved period, you will be required to apply for further extension.

Also note that you will be required to notify the committee of any protocol amendment(s), serious or unexpected outcomes related to the conduct of the study or termination for any reason.

Finally, note that you will also be required to share the findings of the study in both hard and soft copies upon completion.

The JOOTRH ERC takes this opportunity to thank you for choosing this institution and wishes you the best in your endeavours.

Yours sincerely,

DR. MARY A. ONYANGO,
For: SECRETARY – ERC,
JOOTRH – KISUMU.

Appendix 6: Informed Consent

INFORMED CONSENT FROM

TITLE OF THE RESEARCH STUDY: TRENDS IN AGE OF CHILDREN <10 YEARS WITH SEVERE MALARIAL ANAEMIA IN WESTERN KENYA, AND THEIR CAREGIVERS' TREATMENT-SEEKING BEHAVIORS

Investigator(s) and institutional affiliations

Principle Investigator,

Stacey Maureen Okallo Gondi (Maseno University, School of Public Health and community development)

Co investigators,

Prof Collins Ouma (Maseno University)

Dr Walter Otieno (Maseno University)

Dr Harrysone Atieli (Maseno University)

The finances to conduct this research has been provided by GlaxoSmithKline (GSK)

Study location:

The study will be conducted at Jaramogi Oginga Odinga Teaching and Referral hospital (JOOTRH)

Purpose of the Research:

The Maseno University is doing a research study at the Jaramogi Oginga Odinga Teaching and referral hospital. Stacey Okallo Gondi of the University of Maseno would like you to participate in the study since your child has been diagnosed to have severe malarial anaemia and is under 10 years of age. The purpose of the study will be to find out if the implementation of malaria control strategies is leading to a shift in age of severe malarial anaemia infection from younger to older

children. It will also find out the costs involved in the management of severe malarial anaemia at different ages and the capability of the care takers to recognize severe anaemia. Lastly the study will find out the health care options used by the caretakers in managing severe malarial anaemia and the outcomes of severe malarial anaemia attack at different ages.

Description of the Research:

Should you agree to participate in the study, you will be asked some questions as per concerns your child and yourself. The questions you will be asked will only be related to your child's current illness. Some of the questions that you will be asked will include name, age, sex, level of education for yourself and the child. You will be asked some information concerning the illness of your child from the onset of the illness up to the time of discharge from the ward or in the unlikely event up to the time of death. Some information will also be got from the child's hospital records as per concerns the current admission. The questions that you will be asked will take about 30 minutes. You are free to refuse to answer any questions at any time without any consequences. You are also free to withdraw from the study at any time. Should you refuse to participate in this study, you will continue to get the treatment you are entitled to at the hospital.

No tests will be done as far as this study is concerned. The only tests that will be done to you will be as per the hospitals management of the condition your child has. We will thus not draw any blood from yourself or that of your child.

Potential Harm, Injuries, Discomforts or Inconvenience, Risks:

There will be no known harm/risk to you as far as this study is concerned. Only some time will be required from you to answer questions on the questionnaire.

Potential Benefits:

You may not benefit directly from participation in the study, but the information collected will be useful to the researches and policy makers who are working very hard in trying to make this part of the world a malaria free zone.

Confidentiality:

No information that neither reveals your identity nor of your child will be released or published. The Maseno ERC or other health regulatory authorities may review the data collected for purposes of monitoring the study.

The study records will be kept in locked cabinets with no unauthorized access. Only the research study staff will have access to the study records. At the end of the study, there will be no way to link your name with your data

Participation:

You will be given a copy of the signed and dated consent form to keep.

Contacts:

For any questions or concerns about the study or in the event of a study-related injury, the contact person is the principal investigator, P.O BOX 1854, Kisumu. Kenya, Code 40100, telephone number is 0722430933. You can also contact Prof Collins Ouma P.O BOX, Private Bag Maseno, Telephone 0720381214, Dr Walter Otieno, P.O BOX, Private Bag Maseno, telephone 0714481488, Dr Harrysone Atieli P.O BOX, Private Bag Maseno, telephone 0721347437.

For any questions pertaining to rights as a research participant, you can contact, Maseno Ethics Review Committee, P.O Box Private Bag, Maseno, Kenya, telephone 057 351622.

Informed Consent Agreement.

Should you agree to participate in the study, please sign your name below, indicating that you have read and understood the nature of the study, your responsibilities as a study participant, the Inconveniences associated with voluntary participation in the study and that all your questions and concerns concerning the study have been answered satisfactorily. You will receive a copy of this signed consent form to take away with you.

Right thumbprint if illiterate

Childs Name _____

Parents/Guardians Name _____

Parents/Guardian Signature _____ Date_____

*Name of person obtaining Consent*_____

Signature of person obtaining Consent _____ Date _____

(If parent/ guardian are illiterate, an impartial witness will witness for her. The illiterate parent/guardian will thumbprint and the witness will write the name of the child plus that of the parent/guardian and put the date).

Name of witness _____

Signature of witness _____ Date _____

FOMU YA IDHINI YA KUARIFIWA

Jina la Utafiti:

MIENENDO YA UMRI KWA WATOTO CHINI YA MIAKA 10 WENYE MALARIA YA UPUNGUFU WA DAMU MAGHARIBI MWA KENYA, NA TABIA ZA KUTAFUTA TIBA KWA WALEZI WAO

Mtafiti/watafiti na taasisi husika

Mtafiti Mkuu,

Stacey Maureen Okallo Gondi (Chuo Kikuu Cha Maseno, Shule ya Afya ya Uma na Maendeleo ya Jamii)

Watafiti washirika,

Prof. Collins Ouma (Chuo Kikuu cha Maseno)

Otieno (Chuo Kikuu cha Maseno)

Dkt. Harrysone Atieli (Chuo Kikuu cha Maseno)

Fedha zakuendesha utafiti huu zimetolewa na GlaxoSmithKline (GSK)

Eneo la Utafiti:

Utafiti utaendeshwa katika Hospitali ya Mafunzo na Rufaa ya Jaramogi Oginga Odinga (JOOTRH)

Dhamira ya Utafiti:

Chuo Kikuu Cha Maseno kinafanya utafiti katika Hospitali ya Mafunzo na Rufaa ya Jaramogi Oginga Odinga. Stacey Okallo Gondi wa Chuo Kikuu Cha Maseno angependa wewe ushiriki katika utafiti kwani mtoto wako amepatikana kuwa na ugonjwa wa malaria juu ya upungufu mkubwa wa damu na yuko chini ya miaka 10 katika umri. Dhamira ya utafiti itakuwa ni kutafuta iwapo utekelezaji wa mikakati ya kudhibiti malaria inaongoza katika kubadilika kwa umri wa maambukizi ya malaria juu ya upungufu mkubwa wa damu kutoka kwa watoto wadogo mpaka

watoto wakubwa. Pia utajua gharama iliyohusika katika usimamizi wa malaria juu ya upungufu mkubwa wa damu katika umri tofauti na uwezo wa wahudumu kutambua upungufu mkubwa wa damu. Mwishoe utafiti utajua chaguzi za huduma za afya zinazotumiwa na wahudumu kusimamia malaria juu ya upungufu mkubwa wa damu na matokeo ya shambulio ya malaria juu ya upungufu mkubwa wa damu katika umri tofauti.

Maelezo ya Utafiti:

Ukikubali kushiriki katika utafiti, utaulizwa maswali kadhaa yanayohusiana na mtoto wako na wewe mwenyewe. Maswali utakayoulizwa yatahusiana tu na maradhi ya sasa ya mtoto wako. Baadhi ya maswali utakayoulizwa ni pamoja na jina, umri, jinsia, kiwango chako cha masomo na cha mtoto. Utaulizwa baadhi ya habari kuhusiana na maradhi ya mtoto wako tokea mwanzo wa maradhi hadi wakati wa kutoka wodi au katika tukio lisiloweza kukwepwa hadi wakati wa kifo. Baadhi ya habari pia yatapatikana kutoka kwa rekodi za hospitali ya mtoto wako yanayohusisha malazi kwa sasa. Maswali utakayoulizwa yatachukuwa kama dakika 30. Uko huru kukataa kujibu maswali yoyote kwa wakati wowote bila matokeo yoyote. Pia uko huru kujiondoa kutoka katika utafiti wakati wowote. Ukikataa kushiriki katika utafiti huu, utaendelea kupata matibabu unayostahili katika hospitali.

Hakuna jaribio zitakazofanywa mbali na vile utafiti huu umehusishwa. Jaribio tu zitakazofanywa kwako zitalingana na usimamizi wa hospitali ya hali anayo mtoto wako. Hatutatoa damu yoyote kutoka kwako au ile ya mtoto wako.

Madhara, Majeraha, Usumbufu, Hatari:

Hakutakuwa na madhara/hatari inayojulikana kwako mbali na vile utafiti huu umehusishwa. Muda kiasi tu ndio utatakiwa kwako kujibu maswali katika orodha ya maswali.

Manufaa:

Hauwezi nufaika moja kwa moja kutokana kwa kushiriki katika utafiti, lakini habari yaliyokusanywa yatakuwa muhimu kwa utafiti na watunga sera ambao wanafanya kazi kwa bidii sana katika kujaribu kulifanya sehemu hii ya dunia kuwa ukanda huru wa malaria.

Siri:

Hakuna habari inayoonyesha kitambulisho chako au cha mtoto wako itakayotolewa au kuchapishwa.

Kamati ya Maadili ya Maseno au mamlaka nyingine ya kawaida ya afya yanaweza pitia data yaliyokusanywa kwa dhamira ya kufuatilia utafiti.

Rekodi za utafiti zitawekwa katika kabati zinazofungwa zisizo na fursa ya kufikiwa kwa urahisi. Ni wafanyikazi wa utafiti tu ndio wanafursa ya kufikia rekodi za utafiti. Mwishoni mwa utafiti, hakutakuwa na njia yoyote ya kuhusisha jina lako pamoja na data.

Kushiriki:

Utapatiwa nakala ya fomu ya idhini iliyotiwa sahihi na tarehe uweke.

Kuwasiliana:

Kwa maswali yoyote au jambo juu ya utafiti au katika tukio la jeraha linalohusiana na utafiti, Yule mtu wa kuwasiliana naye ni mtafiti mkuu, S.L.P 1854 - 40100, Kisumu, Kenya.

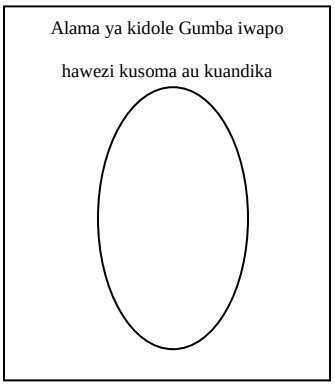
Nambari ya Simu ni 0722 430 933. Unaweza pia kuwasiliana na Prof Collins Ouma S.L.P, Private Bag Maseno, Nambari ya Simu 0720 381 214, Dkt. Walter Otieno, Private Bag Maseno, Nambari ya Simu 0714 481 488, Dkt. Harrysone Atieli S.L.P, Private Bag Maseno, Nambari ya Simu 0721347437.

Kwa maswali yoyote yanayohusiana na haki zako kama mshiriki wa utafiti, unaweza wasiliana na Kamati ya Maadili ya Maseno, S.L.P, Private Bag Maseno, Kenya. Nambari ya Simu 057 351 622.

Makubalino ya Idhini ya Kuarifiwa.

Ukikubali kushiriki katika utafiti, tafadhali tia sahihi, jina lako hapo chini, kuonyesha kuwa umesoma na kuelewa asili ya utafiti, majukumu yako kama mshiriki wa utafiti, usumbufu yanoyohusiana na kujitolea kushiriki katika utafiti na maswali yako yote na mambo yanayohusiana na utafiti yamejibiwa kwa kuridhisha. Utapokea nakala ya fomu hii iliyotiwa sahihi kuenda nayo.

Jina la Mtoto_____



Jina la Mzazi/Mlezi_____

Sahihi ya Mzazi/Mlezi_____ Tarehe _____

Jinala mtu anayetoa Idhini_____

Sahihi ya mtu anayetoa Idhini_____ Tarehe_____

(Iwapo mzazi/mlezi hawawezi kusoma au kuandika, shahidi mwadilifu atamshuhudia. Mzazi/mlezi asiyeweza kusoma au kuandika atatia alama ya kidole gumba na shahidi ataandika jina la mtoto pamoja na lile la mzazi/mlezi na kutia Tarehe).
Jina la shahidi_____

Sahihi ya shahidi_____ Tarehe_____

OTAS YIERUOK

NYING NONRO: KAKA NYITHINDO MA HIKGI TIN NE 10 MANTIE HO MALARIA MANGE'NY KOD REMMO MANOKMANTIE E KENYA MAINBO, KAACHIEL GI JOMA RITOGI-JO HINYOGA DWAROYORE MAG THIETH

Jotend Nonro kod Migepe mantie

Jatend Nonro,

Stacey Maureen Okallo Gondi (Maseno University, School of Public Health and community development)

Jakony Jatend Nonro,

Prof Collins Ouma (Maseno University)

Dr Otieno (Maseno University)

Dr Harrysone Atieli (Maseno University)

Omwom maitimogo nonroni ose chiw kod GlaxoSmithKline (GSK)

Kar Timo Nonro:

Nonro ibiro tim kar thieth ma Jaramogi Oginga Odinga Teaching and Refferal Hospital (JOOTRH)

Gima Omiyo itimo Nonro:

Mbalariany ma Maseno timo nonro kar thieth ma Jaramogi Oginga Odinga Teaching and Referral Hospital. Stacey Okallo Gondi mar Mbalariany man Maseno gombo ni mondo ichiwri enonro nikech nyathini duoko osenyiso ni engi malaria motegno mamiyo remo doko matin kendo otin ne higni 10. Gima omiyo itimo nonro en mar nono katimo yore mag geng'o landruok mar malaria kelo lokruok e higni mag malaria motegno mamiyo remo doko matin koa kuom nyithindo matindo nyako nyithindo madongo. Bende obiro ng'iyo kar romb omwom maitiyogo

kuom thieth mar malaria motegno mamiyo remo doko matin kuom higni mopogore kendo nyalo mar jorit mag thieth efuenyo remo matin ahinya. Mogik nonro biro dwaro thieth manyalore mantie ma itiyogo kod jorit mag thieth ethiedho malaria motegno mamiyo remo doko matin kod duoko mag malaria motegno mamiyo remo doko matin ka ogoyo nyathi ehigni mopogore.

Lero Nonro:

Ka iyie chiwri enonro, ibiro penji penjo motudre kod nyathini kod in bende. Penjo ma ibiro penji biro manaluwore kod tuo mar nyathini esani. Bath penjo ma ibiro miyi biro ting'o nying, higni, kit dhano, kama ichopoe kuom somo kod mar nyathi. Ibiro penji penjo kuom tuo mar nyathini koa chakruok mar tuo nyaka wuok ewod kata maok ogen seche mag tho. Weche moko ibiro yud koa kuom oboke mar thieth mar osiptal kaluwore kod bedo ewod masani. Penjo ma ibiro penji biro kawo dakika 30. Inyalo tamri duoko penjo moro amora saa asaya maonge kum moro amora. Bende in gi thuolo mar wuok enonro esaa asaya. Ka itamri chiwri enonroni, pod ibiro mana yudo thieth ma owinjore kodi e osiptal.

Onge pim ma ibiro tim kaluwore kod nonroni. Pim ma ibiro tim en mana kaka osiptal dwaro maluwore kod tuo mar nyathini. Miyo ok wabi golo remo moro amora koa kuomi kata kuom nyathini.

Rach Manyalo betie, Hinyruok, Winjo marach kata Chandruok, Rach maok ong'e:

Onge rach mabiro betie / rach maok ong'e ne in maluwore kod nonroni. Mana ni thuolo mari ema ibiro dwar mondo iduok penjo kaluwore gi oboke penjo.

Ber Manyalo betie:

Ok inyal yudo ber moriere kuom chiwruok enonro, to weche mochoki biro bedo kod tich ne jononro kod jolos chik matiyo matek mondo oketi bath piny makoni kama onge malaria

Maling'ling':

Onge wach mabiro fuenyi kata fuenyo nyathini ewach maibiro golo kata ndiko e oboke. Jo ERC Maseno kata jo regulatory mag thieth nyalo rango weche mochoki ne ng'iyo kaka nonro itimo.

Oboke mag nonro ibiro kan e kabat molor maonge kod thuolo ne ji maok owal machope. Mana jatij nonro ema ibiro miyo thuolo kuom oboke mag nonro. Egiko mar nonro, biro bedo ni onge yo ma itudogo nyingi gi weche mochoki.

Chiwruok:

Ibiro miyi otas machal kod mae moketie seyi mondi ibedgo.

Tudruok:

Kuom penjo moro amora kata paro maluwore kod nonro kata ka nintie hinjruok maluwore kod nonro, jal ma itudruokgo en jatend nonro, P.O BOX 1854, Kisumu. Kenya, Code 40100. Namba Simo 0722430933. Inyalo bende tudri kod Prof Collins Ouma P.O BOX, Private Bag Maseno, Simo 0720381214, Dr Walter Otieno P.O BOX, Private Bag Maseno, Simo 0714481488, Dr Harrsisone Atieli P.O BOX, Private Bag Maseno, Simo 0721347437.

Kuom penjo moro amora maluwore kod chiwruok enonro, inyalo tudri kod , Maseno Ethics Review Committee, P.O Box Private Bag, Maseno, Kenya. Simo 057 351622.

Yierruok mar Oboke Winjruok.

Ka iyie chiwri enonro, yie iket seyi mar nyingi pinyka, kanyiso ni isesomo kendo winjo kit nonro, tiji kaka jachiwre e nonro, chandruok matudore kod chiwruok kuom hero ng'ato e nonro kendo ni penjoni kod paro maluwore kod nonro oseduoki mowijore. Ibiro yudo otas machal kod mae mondo idhi godo.

Nying Nyathi _____

Lwedo mathuon mar achich ka ok nyal ndiko

Nying Janyuol/Jarit _____

Seyi mar Janyuol/Jarit _____ Tarik _____

Nying Jal makawo yieruok_____

Seyi mar Jal makawo yeiruok _____ Tarik _____

(Ka janyuol / jarit ok nyal somo kata ndiko, janeno biro chung'ne. Janyuol / Jarit maok nyal somo kata ndiko biro keto lwete mathuon kendo janeno biro ndiko nying nyathi kod mar janyuol /jarit eka oketo tarik).

Nying Janeno _____

Seyi mar janeno _____ Tarik _____

Appendix 7: Publications from this work

International Journal of TROPICAL DISEASE & Health

35(3): 1-9, 2019; Article no.IJTDH.47591
ISSN: 2278–1005, NLM ID: 101632866

Health Care Seeking Behavior among Caregivers of Sick Children Who Had Severe Malarial Anaemia

Stacey M. O. Gondi[1*], Collins Ouma[2], Harrysone Atieli[1] and Walter Otieno[3]

[1]Department of Public Heath, Maseno University, Maseno, Kenya.
[2]Department of Biomedical Sciences and Technology, Maseno University, Maseno, Kenya.
[3]Department of Pediatrics and Child Health, Maseno University School of Medicine, Kenya.

Authors' contributions

This work was carried out in collaboration among all authors. Author SMOG designed the study, wrote the protocol, performed the statistical analysis and wrote the first draft of the manuscript. Authors CO, HA and WO performed the statistical analysis and managed the literature searches. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: The western region in Kenya is holoendemic to malaria and experience stable *P. falciparum* malaria transmission. The use of health care options has a direct influence on the outcome of severe malaria. As such, the current study will assess the health care seeking behavior among caregivers of sick children who had severe malarial anaemia (SMA) in western Kenya.
Study Design: Cross section study.
Place and Duration of Study: The study was conducted at Jaramogi Odinga Oginga Teaching and Referral Hospital (JOOTRH) between September 2014 to July 2015.
Methodology: It was open to all children ≤10 years (n=271) admitted and diagnosed with SMA (hemoglobin <5.0 g/dl and any density of *P. falciparum*. Caregivers were interviewed on the health care options before seeking care at a heath facility, when the child started to get sick, if they took child to another health centre/dispensary/private hospital before coming to JOOTRH
Results: Majority of the caregivers interviewed, 80.07% (217) had attained Primary education. Majority of the caregivers were in the age category of 19-24 75(27.67%) years and 25-29 years 75

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International Journal of TROPICAL DISEASE & Health

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ISSN: 2278–1005, NLM ID: 101632866

Cost of Treatment of Severe Malarial Anemia in Children Living in Western Kenya

Stacey M. O. Gondi[1*], Collins Ouma[2], Harrysone Atieli[1] and Walter Otieno[3]

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[2]Department of Biomedical Sciences and Technology, Maseno University, Maseno, Kenya.
[3]Department of Paediatrics and Child Health, Maseno University School of Medicine, Kenya.

Authors' contributions

This work was carried out in collaboration between all authors. Author SMOG designed the study, wrote the protocol, performed the statistical analysis, and wrote the first draft of the manuscript. Authors CO, HA and WO and performed the statistical analysis and managed the literature searches. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: The Western region in Kenya is holoendemic to malaria and experiences stable *P. falciparum* malaria transmission. Households and healthcare providers in this region incur costs in the management of malaria and malaria related complications. However, information regarding the cost of severe malaria anemia (SMA) management remains almost unknown. The aim of this study was to study the costs incurred by the household and healthcare providers in the management of SMA in children of 10 years and below.

Study Design: Cross-section study.

Place and Duration of Study: Jaramogi Odinga Oginga Teaching and Referral Hospital (JOOTRH) from September 2014 to July 2015.

Methodology: It was open to all children ≤10 years (n=271) admitted and diagnosed with SMA (hemoglobin <5.0 g/dl and any density *P. falciparum* parasitemia). Data were extracted from the participants' medical files. Parents/guardians of the participants were interviewed on the costs incurred throughout the management of the disease.

**Corresponding author: E-mail: dotigondi3@gmail.com;*