UPTAKE OF MALARIA VACCINE (RTS, S/AS01), INSECTICIDE TREATED NETS (ITNs) AND MALARIA INFECTIONS AMONG CHILDREN AGED 6-36 MONTHS IN MUHORONI SUB-COUNTY, KISUMU COUNTY KENYA

BY

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A Thesis Submitted in Partial Fulfillment of the Requirements for the Award of the Degree of

MASTER OF SCIENCE IN EPIDEMIOLOGY AND BIOSTATISTICS

Department of Public and Community Health

SCHOOL OF HEALTH SCIENCES

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DECLARATION AND APPROVAL

Declaration

This thesis is my original work and has not been presented for an award of a degree in any other university or institution.

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H153/P/0134/2021

Supervisor's Approval

This proposal has been submitted for examination with our approval as university supervisors.

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DEDICATION

I dedicate this work to my family and friends for their encouragement and the overwhelming support they accorded me during my entire study period. A special gratitude to my family Eng. Michael Alago, Mr. Jackson Okanda, Mia Mich, Mrs. Jackline Okanda, and Mr. John Seda for their immense support throughout this journey.

ACKNOWLEDGMENT

I thank God for His guidance and provision throughout this journey.

I acknowledge my supervisors Prof. George Ayodo and Prof. Erick Okuto, for their unreserved support throughout the research process.

I acknowledge Jaramogi Oginga Odinga University of Science and Technology administration for their support throughout this journey.

I acknowledge Kisumu County MOH for their support in research, and a special thanks to my family and friends for their unending support.

Finally, I acknowledge the European Developing Countries Clinical Trial Partnership (EDCTP)for their overwhelming support in research and entire studies. This research was supported by the Capacity Development of Applied Epidemiologists in the Eastern Africa Region (CDAE). This project is part of the European and Developing Countries Clinical Trials Partnership II (EDCTP2) Programme supported by the European Union. CDAE is jointly implemented by the African Population and Health Research Center (APHRC), the Amref International University (AMIU) and the Jaramogi Oginga Odinga University of Science and Technology (JOOUST) and funded by the EDCTP2 (grant: CSA2020E-3139).

LIST OF ABBREVIATIONS AND ACRONYMS

ACT-	Artemisinin-based Combination Therapies
AIDS-	Acquired Immunodeficiency Syndrome
CHV-	Community Health Volunteer
IPTp-	Intermittent Preventive Treatment for pregnant women.
IRS-	Indoor Residual Spraying
JOOTRH-	Jaramogi Oginga Odinga Teaching and Referral Hospital
JOOUST-	Jaramogi Oginga Odinga University of Science and Technology
KEMRI-	Kenya Medical Research Institute
KII-Key	Informant Interviews
LLITN-	Long Lasting Insecticide Treated Nets
ITNs -	Insecticide Treated Nets
MOH-	Ministry of Health
MVIP-	Malaria Vaccine Implementation Programm
NACOSTI-	National Commission for Science, Technology and Innovation.
PMI-	President Malaria Initiative
SSA-	Sub Saharan Africa
WHO-	World Health Organization.

OPERATIONAL DEFINITION OF TERMS

Malaria prevention measures – These are interventions in place to prevent malaria infection.

Malaria occurrence -This refers to the episode of malaria infection.

RTS, S/AS01- This scientific name for the malaria vaccine.

Letter R represents the central repeat region of P. falciparum circumsporozoite protein (CSP), T stands for the T-cell epitope of the circumsporozoite, and S stands for the surface antigen of hepatitis B. The three are combined in one fusion protein RTS and co-expressed in a yeast cell with free HBaAg. RTS and free S protein assembles in RTS, S particles. RTS.S also contains the AS01 adjuvant system and is scientifically called RTS, S/AS01.

STATA-This is a statistical software developed for data manipulation, visualization, statistics and automated reporting.

Universal net coverage- Availability of at least one-bed net for two people in a household.

ABSTRACT

Globally in 2020, about 241 million malaria cases were reported resulting in about 627,000 deaths (Sarfo *et al.*, 2023). Of all the death cases, 96% were from Africa, and 77% of them were children below five years of age (Ng'ang'a *et al*., 2021)(F. Achieng *et al*., 2020). Of an estimated 405,000 malaria deaths per year, more than half occur in children below five years and are caused by P. falciparum (Ashley & Poespoprodjo, 2020). Malaria vaccine and Insecticide-treated are among the malaria prevention and control interventions, however, there are limited data on their coverage and their association with the malaria infection. This study aimed to assess the uptake of malaria vaccine and Insecticide-treated nets use and their association with malaria infection among children aged 6-36 months in Muhoroni sub-county, Kisumu county. A cross-sectional study using a quantitative approach was used. The strata and simple random sampling were applied to get 319 children from a 13,502 sample population, and a structured questionnaire was used. Descriptive statistics and Logistic regression were used to describe and determine the association between independent variables and malaria infection using STATA Version 16. The results showed that 67.57% of the children were positive for malaria infection in the past six months. In addition, uptake of RTS, S malaria vaccine is as follows; first dose 72.10% coverage, second dose 66.68%, third dose 59.40%, and fourth dose 31.35%, respectively. Children who did not receive the recommended RTS, S as per their ages were 4 times more likely to get malaria infection than their counterparts who received RTS, S as recommended [AOR=4.07, 95%CI=1.51-11.01, P=0.006]. A child who did not sleep under an insecticide-treated net was 12 times more likely to get malaria infection than a child who slept under an ITN [AOR=11.61,95%CI=1.10-122.59, P=0.041]. With every increase in Age, a child was twice as likely to get malaria infection [AOR=2.22,95%CI=1.22-4.02, P=0.009]. The study concluded that there is low uptake of RTS, S, especially the third and fourth dose in the Muhoroni sub-county since not a single dose met the World Health Organization uptake target of 90% coverage of each dose, ITN use in the area is high. Not receiving the recommended RTS, S dose and not sleeping under ITN increases the risk of malaria infection. Age was a risk factor for malaria infection. The Study recommended health education initiatives to promote vaccine awareness and targeted interventions to boost malaria vaccine coverage in the region, we recommended the need for further studies to find reasons for low malaria vaccine uptake.

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CHAPTER ONE: INTRODUCTION

1.1 Background Information

Globally in 2020, about 241 million malaria cases were reported resulting in about 627,000 deaths (Sarfo *et al*., 2023). Of all the deaths, 96% were from Africa, and 77% of them were of children below five years of Age(Ng'ang'a et al., 2021) this was an increase as compared to 2019, which had about 229 million malaria cases accounted to 40 000 deaths and among those, 90% occurred in Sub-Saharan Africa (SSA) (Unwin *et al*., 2021). Malaria is the world's leading killer disease of infants and children below five years (F. Achieng *et al.,* 2020). SSA and other endemic regions are the most affected with children below five years of age being the most vulnerable accounting for more than two-thirds of all malaria deaths worldwide (Sulaiman *et al.,* 2022). Of an estimated 405,000 malaria deaths per year, more than half occur in children below five years and are caused by *P. falciparum* (Ashley & Poespoprodjo, 2020). Malaria is a significant public health issue in countries where it is endemic, particularly among children under five (Dimala *et al.*, 2018; Patouillard *et al*., 2017).

In 2020, there were about 27 million cases of Malaria in Kenya, which attributed to 12,600 deaths in the county (Ondeto *et al.*, 2022). Malaria infection is the leading cause of morbidity and mortality in the country, with approximately 25 out of 35 million Kenyans (more than 70%) being at risk of Malaria(Okoyo *et al*., 2021). *P. falciparum* is the leading species causing severe infection resulting in more than 99% of overall malaria infections in the country and approximately 70% of the total population being at risk for malaria (President & Initiative, 2019). Approximately 10,700 deaths and 3.5 million new clinical malaria cases each year occur in the country; this poses the disease as a major threat and public health burden in Kenya (Miranville, 2019). In Kenya, 84 per 1000 live

births die before their fifth birthday with the disease in children under five years being estimated to be around 70% of all cases of malaria worldwide and 80 percent of overall cases in Kenya in 2015 (Okoyo *et al.*, 2021). There are several malaria prevention methods used in Kenya such as early diagnosis and timely administration of artemisinin-based combination treatments (ACTs), intermittent preventive treatment for pregnant women (IPTp), as well as the use of insecticide-treated bed nets (ITN) and indoor residual spraying (IRS) (President & Initiative, 2019). Despite the several interventions mentioned above implemented to mitigate the prevalence of Malaria, it continues to persist as a significant public health concern in Kenya, particularly impacting children aged five and below (Ye *et al.,* 2020).

According to the findings of the Kenya Indicator Survey 2020, there has been a decline in the ownership of at least one ITN among households in Kenya. The data indicates that the proportion of households possessing an ITN has decreased from 63% to 49%. The proportion of families with a bed net for every two individuals who slept in the household the night before the survey amounted to 29 percent, the prevalence of children under the age of 5 years and pregnant women who used ITNs for sleeping the night before the survey was 42% and 40%, respectively. Upon examining the prevalence of Malaria, it was observed that there was a decrease in the use of ITNs among children under the age of 5 in families possessing at least one ITN across all areas. The Lake endemic zones saw the most significant decline, with a fall of 13% seen between 2015 (82%) and 2020 (69%). This finding indicates that the use of ITN remains a persistent difficulty. Given that Kisumu County is located in an area characterized by many diseases endemic to lakes, it is essential to evaluate the use of ITNs to ensure adequate coverage.

In April 2017, the World Health Organization (WHO) made the declaration to implement the RTS, S vaccine in a cluster randomized design within the selected pilot regions of Kenya, Ghana, and Malawi. The Mosquirix vaccine, also known as RTS, S /AS01, or simply RTS, S, has been established as the first vaccination to demonstrate partial efficacy in protecting against malaria (Tabiri *et al.,* 2021), and it's the most clinically advanced and endorsed by the World Health Organization (Samuels *et al*., 2022). In the Study, children five months and older were delivered four doses of the RTS, S/AS01E vaccine. Three vaccinations were administered for children aged 5-9 months residing in regions with moderate-to-high transmission of malaria illness. The fourth dosage was given 15-18 months after the first vaccination. The Study revealed that the vaccination demonstrated a reduction of 39% in clinical malaria cases and a reduction of 29% in severe malaria cases. According to Praet *et al.* (2022), the administration of the vaccine was shown to be correlated with a decrease in the occurrence of severe anemia, a diminished need for blood transfusion, a decrease in hospitalizations due to malaria, and an overall reduction in hospitalizations.

The authority to use RTS, S/AS01E in Kenya was granted on September 13, 2019 (Praet, Asante, Bozonnat, & Akité, 2022) *et al.*, 2022). On October 2019, the country rolled out malaria vaccine in some parts of the eight counties in western Kenya that is Kisumu, Homabay, Migori, Siaya, Vihiga, Kakamega, Bungoma, and Busia (Praet, Asante, Bozonnat, Akité, *et al.*, 2022). In October 2021, there was a recommendation by the WHO for RTS, S/AS01E, to be administered to children to prevent *P. falciparum* malaria in children living in moderate to high transmission regions as part of the comprehensive strategy for malaria control.

A study in Ghana in 2021 showed a declining uptake for the subsequent vaccine doses. The first dose uptake was 94.1%; it reduced to 90.6% for the second and 78.1% for the third; no data was taken on the fourth dose(Tabiri *et al*., 2021). RTS, S 1 and RTS, S 2 uptake met the WHO target of 90% of RTS, S uptake, but uptake of RTS, S 3 did not; WHO targets 90% uptake of all RTS, S doses (Tabiri *et al*., 2021). It is therefore important to assess malaria occurrence, RTS, S uptake, and ITN use in a rural endemic area in Kisumu County Muhoroni sub-county. To achieve the global technical strategy target 2016-2030 of reduction of Malaria globally by at least 90 percent in malaria incidence and mortality cases and to eliminate Malaria by 2030 in at least 25 counties, we needed to know the current occurrence of malaria infection in children in Muhoroni sub-county. To meet the WHO RTS, S coverage target of 90%, there is a need to assess the uptake for proper actions. There was a need to identify the current usage of ITN in the Muhoroni sub-county and assess the association they have with malaria infection. This Study's objective was to assess the uptake of RTS, S vaccine and ITN use among children 6-36 months, and to find out the association of the two malaria prevention measures on malaria infection in Muhoroni sub-county.

1.2. Statement of the Problem

Muhoroni sub-county being in a lake endemic zone has a malaria prevalence of 19% in children(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021). This show that malaria in children in still high in lake endemic zone and Muhoroni sub-county being situated in this zone, has the same burden. There are various malaria prevention strategies being implemented in this sub-county, however, this study is going to assess only RTS, S uptake and ITN use and their association on malaria infection.

In October 2021, there was a recommendation by the WHO for RTS, S/AS01E to be administered to children for the prevention of *P. falciparum* malaria in children that live in moderate to high transmission regions as part of the comprehensive strategy for malaria control (Praet, Asante, Bozonnat, & Akité, 2022), according to a study done in Ghana in 2021 that assessed factors associated with the uptake of malaria vaccine in Sunyani Municipality, RTS, S uptake of doses 1,2 and 3 had 94.1%,90.6% and 78.1%, respectively. The above information showed that only doses 1 and 2 met the WHO coverage target of 90%. RTS, S dose three did not meet the target, and the last dose uptake was unknown (Tabiri *et al.*, 2021).

A study done in the western region in Kenya which examined the malaria vaccine coverage estimation using age-eligible populations and service user denomination revealed that overall, service-based malaria vaccine coverage was 96%, 87%, 78%, and 39% for doses 1–4 respectively. Based on the population-derived denominator for age-eligible children, vaccine uptake was 78%, 68%, 57%, and 24% for doses 1–4, respectively(Moturi *et al*., 2023). This showed a gap in vaccine uptake, thus the need for assessment on the current uptake.

According to the findings of the Kenya Indicator Survey 2020, it was observed that 49% of households in Kenya had at least one Insecticide-Treated Net (ITN), indicating a decline from the previous figure of 63%(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021). The proportion of families possessing a bed net for every two individuals who slept in the household the night before the survey amounted to 29 percent. The prevalence of children under the age of 5 years and pregnant women who used insecticide-treated bed nets (ITNs) for sleeping purposes on the night before the

survey was 42% and 40%, respectively. It was observed that there was a decrease in the use of insecticide-treated bed nets (ITNs) among children under the age of 5 in homes with at least one ITN, lake endemic zones saw the most substantial decline, with a fall of 13% seen between 2015 (82%) and 2020 (69%)(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021). Based on the findings from the above studies, it is therefore important to assess the uptake of these two interventions in Muhoroni sub-county situated in lake endemic region.

1.3 Objectives

1.3.1. Broad Objective

To assess uptake of RTS,S and ITN and their association on malaria infections among children aged 6-36 months in Muhoroni Sub-county, Kisumu County, Kenya.

1.3.2. Specific Objectives

i. To determine the occurrence of malaria infection among children 6-36 months in Muhoroni sub-county, Kenya.
ii. To assess the uptake of RTS, S vaccine, and ITN among children (6-36 months) in Muhoroni, Sub-county, Kisumu County, Kenya.
iii. To identify the association of RTS, S uptake and ITN on malaria infection among children 6-36 months in the Muhoroni Sub-county, Kenya.

1.4. Research Questions

i. What is the occurrence of malaria infection among children 6-36 months in Muhoroni sub-county, Kenya?
ii. What is the uptake of RTS,S and ITN usage among children (6-36 months) in Muhoroni, Sub-county, Kenya?

iii. What is the association of RTS, S vaccine and ITN uptake on malaria infection among children 6-36 months in Muhoroni Sub-county, Kenya?

1.5. Justification of the Study

Malaria prevalence is high in the lake endemic zone which covers a wide area, it is important to get the situation from a single rural sub-county to inform the stakeholders of the burden locally rather than the general results. Studies have shown poor malaria vaccine uptake as well as low ITN usage, i.e Kenya Malaria Indicator Survey 2020. These results were on the general lake endemic zone and some counties in Kenya. It is therefore important to get the situation in a local rural sub-county to know the uptake of these interventions in the rural endemic zone.

1.6 Significance of the Study

The results have informed public health policymakers on the uptake of RTS, S, and ITN usage for proper actions to ensure high vaccine coverage and ITN usage in Muhoroni Kisumu County. It has informed stakeholders and the public of the magnitude of malaria infection on 6-36months children in six months' period. It informed decision-makers on the level of malaria prevention interventions used in the area and their association on malaria infection for an informed decision. This will offer evidence-based ideas on the interventions to be put in place to increase Malaria vaccine coverage, and ITN use and reduce malaria occurrence.

1.7. Limitations of the Study

There were 15(4.7%) children who did not have MCH booklets, we therefore used maternal recall which could have some recall bias, however, the study had 5% extra participants for non-response which took care of any bias eventualities.

CHAPTER TWO: LITERATURE REVIEW

2.1. Malaria Epidemiology

Globally in 2020, about 241 million malaria cases were reported resulting in about 627,000 deaths (Sarfo *et al.*, 2023). Of all the deaths, 96% were from Africa, and 77% of them were of children below five years of Age(Ng'ang'a et al., 2021), this was an increase as compared to 2019, which had about 229 million malaria cases accounted to 40,000 deaths and among those, 90% occurred in SSA (Unwin *et al.,* 2021). Malaria is the world's leading killer disease of infants and children below five years (F. Achieng *et al.,* 2020). SSA and other endemic regions are the most affected with children below five years of age being the most vulnerable accounting for more than two-thirds of all malaria deaths worldwide (Sulaiman *et al*., 2022)Of an estimated 405, 000 malaria deaths yearly, more than half occur in children below five years and are caused by *P. falciparum*(Ashley & Poespoprodjo, 2020). In 2018, children below five years of age accounted for 67% (272 000) of all malaria deaths worldwide (Ng'ang'a et al., 2021).

Malaria prevention interventions in SSA include vector control using ITN, IRS and chemoprevention in pregnant women and infants. The global prevalence of malaria declined from around 62% to 41% over the period spanning from 2000 to 2015(Patouillard *et al.,* 2017). The number of nations that reported less than 1000 occurrences of Malaria in 2015 was three times higher than in 2000. Not with standing these factors, the execution of malaria control measures fails to meet the objectives outlined in the global technical plan, and Malaria remains a significant public health concern in countries where the disease is prevalent, particularly among children under the age of five (Dimala *et al*., 2018; Patouillard *et al.,* 2017).

The Global Technical Strategy for Malaria 2016-2030 was established to expedite endeavors to eradicate Malaria, the global technical plan aims to achieve a reduction of at least 90 per cent in the incidence of malaria infections and death cases worldwide, as well as the complete elimination of Malaria in a minimum of 25 countries by 2030(World Health Organization, 2016). Further enhancements include a minimum 40% and 75% decrease in the worldwide disease burden by 2020 and 2025, respectively. The objective is to eradicate Malaria from at least ten countries by 2020 and 20 nations by 2025(World Health Organization, 2016). To accomplish these goals, the Global Technical Strategy (GTS) emphasized the significance of enhancing the availability of malaria interventions, including malaria surveillance, vector control, chemoprevention in populations at high risk, and timely access to malaria diagnosis and treatment in both healthcare facilities and community settings (Patouillard *et al*., 2017). The WHO Malaria Vaccine Technology Roadmap acknowledges the need to develop a safe and efficacious malaria vaccine that prevents morbidity and death and reduces transmission, this is seen as a crucial step towards the ultimate goal of eradicating Malaria (Adeniji *et al*., 2020). In 2022, the World Health Organization (WHO) recommended using RTS, S/AS01E, as a preventive measure against P. falciparum malaria in children residing in regions with moderate to high malaria transmission. This recommendation was made as a component of the all-encompassing approach to malaria control(World Health Organization, 2016). The RTS, S/AS01E vaccine targets the pre-erythrocytic stage of the Plasmodium falciparum parasite to protect against malaria. It is intended for regularly vaccinating young children residing in regions with a significant malaria prevalence, other preventative and control measures must remain in operation as supplementary instruments (Praet *et al.*, 2022).

2.2. Prevalence of Malaria in Kenya

Kenya is in the eastern African region, with around 80% of its land area classified as desert or semi-arid. In comparison, the remaining 20% is deemed arable. The nation has two primary geographical zones: the highlands and the lowlands. The lowlands include the Lake and coastal regions, while the highlands are situated inside the Rift Valley portion of Kenya. The height and closeness to the Indian Ocean have a significant impact on both rainfall patterns and temperatures. The coastline area has a tropical climate characterized by elevated precipitation and temperatures compared to other regions of the nation, persisting consistently throughout the year. These variables have impacted the epidemiology of malaria in the nation. The transmission and risk of malaria infection in Kenya are primarily influenced by factors such as height, patterns of Rainfall, and temperature. The prevalence of malaria infection in Kenya exhibits regional disparities, with the regions around Lake Victoria and the Coastal region seeing the greatest levels of risk. Notably, children under five and pregnant women are more vulnerable to contracting the illness. According to Okoyo *et al*. (2021), the prevalence of malaria among children under the age of 5 accounted for around 70% of all malaria cases worldwide and 80% of all cases specifically in Kenya in the year 2015. According to the Kenya Malaria Strategy 2019-2023, the prevalence of malaria is much higher in the Lake and coastal areas of the nation.

2.2.1. Kenya regions and their risk in malaria infection.

Endemic area (Lake and Coast): These areas have the continuous presence of Malaria with altitudes ranging from 0-1,300 meters around the Lake Victoria region. There is a high rate of vector survival due to favorable climatic conditions and vector short life

cycles in this region. Malaria transmission has been intense throughout the years, with a prevalence of 27% in the lake endemic zone and 8% in the coast endemic zone in 2015.(Kenya Malaria Strategy 2019-2023, n.d.) these areas include Homabay, Kakamega, Vihiga, Migori, Kisumu, Siaya, Bungoma and Busia in Lake Endemic. In contrast, the coastal endemic zone is Kwale, Mombasa Kilifi, Lamu and Taita Taveta (Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021).

Seasonal malaria transmission, semi-arid: Kenya's northern and southeastern regions are characterized by dry and semi-arid climates, with a brief but strong phase of malaria transmission during the rainy season. Elevated temperatures persist consistently, while the formation of water pools during periods of precipitation serves as conducive breeding grounds for malaria vectors. The frequency of the malaria parasite in this particular zone was recorded below 1% in 2015. According to the Division of National Malaria Programme (DNMP) and ICF (2021), The counties included under this geographical zone are Isiolo, Tana River, Turkana, Baringo, Samburu, Meru, Kitui, Embu, West Pokot, Marsabit, Tana River, Tharaka-Nithi, Garissa, Wajir, Mandera, Elgeyo Marakwet, Kajiado, as reported by the Division of National Malaria Programme (DNMP) [Kenya] and ICF in 2021.

Highland Malaria epidemic prone zone. The transmission of malaria in the western highlands has a seasonal pattern characterized by significant year-to-year fluctuations. Malaria epidemics are more likely to develop when climatic circumstances support prolonged low temperatures of around 18°C. This is because such conditions promote the continued reproduction of disease-carrying vectors, facilitating a higher transmission rate of malaria. The whole population of Kenya is vulnerable to the effects of an epidemic,

and the case fatality rate in such situations might be as much as ten times more than anticipated in areas where malaria is prevalent. According to the Kenya Malaria Strategy 2019-2023, the prevalence of malaria in the specified zone during KMIS 2015 was recorded at 3% (Kenya Malaria Strategy 2019-2023, n.d.). The mentioned regions include Bomet, Bungoma, Nyamira, West Pokot, Kakamega, Kisii, Trans-Nzoia, Uasin Gishu, Kericho, Nandi, Narok, and Elgeyo Marakwet (Division of National Malaria Programme [DNMP] & ICF, 2021).

Low-risk malaria regions: This region encompasses Kenya's central highlands, including Nairobi. The consistently low temperatures often hinder the successful completion of the sporogonic cycle of the malaria parasite inside the vector organism. Nevertheless, changes in climate, such as rising temperatures and modifications in the hydrological cycle, can impact the appropriateness of a particular place for rearing malaria vectors. This, in turn, may result in the introduction of malaria transmission to regions where it was previously absent. According to the Kenya Malaria Strategy 2019-2023, the prevalence of malaria parasites in low-risk regions was below 1% in the 2015 Kenya Malaria Indicator Survey (KMIS) (n.d.). The locations mentioned above include Nairobi, Meru, Nyeri, Nyandarua, Kirinyaga, Kiambu, Machakos, Murang'a, Embu, Makueni, Laikipia, Nakuru, and Tharaka-Nithi (Division of National Malaria Programme [DNMP] & ICF, 2021).

The transmission of Malaria has a greater prevalence in rural areas of Kenya as opposed to urban regions. This disparity may be attributed to several factors, including substandard housing conditions, inadequate drainage systems, and elevated disease vectors. The transmission of Malaria is influenced by several variables, including

knowledge, attitudes, socioeconomic conditions, access to healthcare facilities, and preventative initiatives. These factors and climatic conditions have been identified as significant determinants of malaria transmission (Sultana *et al.*, 2017).

2.3. Socio-demographic, economic, and environmental factors and their risks in malaria infection

Socioeconomic factors refer to income, educational level, employment, wealth index, and housing characteristics such as construction materials, water and sanitation facilities, electricity, community safety, and social support. These factors can affect positively or negatively how well and how long we live. These factors affect what choices we make on our health (Fikrie *et al.*, 2021). Studies show that household income and education level are part of the determinants of Malaria. Low-income households have difficulties accessing healthcare, hence the heavy burden of diseases; education level helps improve our health status based on how we comply with prevention strategies (Bah, 2020). Children living in poorly constructed houses have a higher chance of being bitten by mosquitoes as compared to those living in well-constructed houses; parameters like walls, number of windows, open eaves, or breeding sites near the house are strongly associated with increased indoor mosquito abundance, these are according to studies that have been done in the past on malaria (Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021).

Demographic factors refer to gender, age, education status, religion, marital status, and geographical residence, and all have been characterized as important predictors of Malaria in children, pregnant women and the general population (Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021). Environmental factors like altitude,

humidity, Rainfall and temperature are important in the malaria vector transmission cycle. Humidity and temperature are favorable environments for mosquitoes. The warm tropical, subtropical climates and Malaria have a positive relationship. Rainfall contributes to the multiplication of mosquitoes since it creates stagnant ditches and pools, which serve as breeding sites for mosquitoes(Bah, 2020).

2.4. Malaria Prevention Measures

These are strategies in place to prevent and control malaria prevention.

2.4.1. RTS, S

To achieve the global technical strategy 2016-2030, there is a need to have a safe and effective vaccine for malaria infection that prevents morbidity and mortality. The vaccine that reduces transmission to allow eradication of Malaria was agreed upon and noted down in the WHO Malaria Vaccine Technology Roadmap (Adeniji *et al*., 2020). European Medicine Agencies had a positive thought towards the malaria vaccine. In 2015, they recommended a vaccine administered to children at six weeks to 17 months at the first dose. WHO recommended a pilot implementation of RTS, SAS01, in January 2016 on children aged five months in 3-5 countries in SSA with moderate to high malaria burden.

In April 2017, WHO announced the implementation of the RTS S vaccine in a cluster randomized design within select pilot regions of Kenya, Ghana, and Malawi. The selection of these three nations was based on their location within an area characterized by a moderate to high prevalence of Malaria. The National Expanded Programs on Immunization carried out the process as part of the Malaria Vaccine Implementation Programme (MVIP) (Adeniji *et al.*, 2020). Within the intervention framework, four

administrations of RTS, S/AS01E were provided to children aged five years and above. Specifically, children aged between five and nine months residing in regions with moderate to high malaria transmission received three doses, while the fourth dose was offered 15 to 18 months after the first dosage. The findings revealed a reduction of 39% in clinical malaria and 29% in severe malaria. According to Praet *et.al* (2022), vaccination was associated with decreased incidence of severe anemia, diminished need for blood transfusion, lower malaria hospitalization rates, and overall hospitalization. In 2022, WHO recommended the administration of RTS, S/AS01E, as a preventive measure against P. falciparum malaria in children residing in regions with a significant prevalence of malaria transmission. This recommendation was made as a component of the broader malaria control plan. The authorization for using the RTS, S/AS01E vaccine was officially provided to Ghana on April 24, 2018, by the Ghana Food and Drug Board. Similarly, the Kenya Pharmacy and Poisons Board approved Kenya on May 11, 2018, while the Malawi Pharmacy and Medicine Regulatory Authority authorized its usage in Malawi on May 16, 2018. Vaccination commenced in Malawi on April 23, 2019, while in Ghana, it began on April 30, 2019. The vaccination campaign was initiated in Kenya on September 13, 2019 (Praet *et al*., 2022). The vaccine known as RTS, S/AS01E, is the first vaccination to be used as a supplementary measure alongside established therapies outlined in the Global Technical Strategy for Malaria 2016-2030. The vaccine under consideration is a pre-erythrocytic vaccination against *Plasmodium falciparum* malaria, specifically designed for the regular immunization of young children residing in regions with a high prevalence of malaria (Praet *et al*., 2022). As a supplementary instrument, it

is important to maintain the use of other preventative and control measures. This research aims to examine the use of RTS, S and its effects on the occurrence of malaria infection.

2.4.2. Vector control

Management of malaria transmission relies heavily on vector control. Primary malaria prevention largely relies on two vector control mechanisms: IRS and ITNs.

2.4.2.1 Insecticide Treated Nets

ITN is the main intervention for preventing malaria infection in Kenya since it creates a barrier from mosquito bites that cause malaria; it also repels and kills mosquitoes. By reducing the population of vectors, the risk of malaria is reduced at both the individual and community levels. When the ITN coverage is high, it aids in reducing the malaria risk at the individual and community levels when high coverage is achieved(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021).

The major threat to LLIN intervention is the Insecticide resistance of vectors example is resistance to the pyrethroid-based insecticide used on LLINs.(Kenya Malaria Strategy 2019-2023, n.d.). In Kenya, ITNs are distributed every three years through a mass distribution campaign in twenty-seven malaria-endemic, epidemic, and irrigation counties. ITNs are also given out routinely to pregnant women during their visit to ANC clinics through child welfare clinics, and the nets can be locally bought too. Using LLIN and IRS has led to a decrease in vector density, parity, and distribution(President & Initiative, 2019).

It was observed that a total of 49% of households in Kenya had at least one ITN, this figure represents a decline from the previous rate of 63%. As indicated by the poll, the percentage of houses with a ratio of one net per every two individuals present in the

household on the preceding night was 29%(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021). According to the Division of National Malaria Programme (DNMP) in Kenya and the International Classification of Functioning, Disability and Health (ICF) in 2021, the prevalence of children under the age of 5 and pregnant women who used insecticide-treated bed nets (ITN) for sleeping the night before to the survey was found to be 42% and 40% respectively(MOH, 2016). There was a decrease in the use of insecticide-treated bed nets (ITNs) among children under 5 in homes with at least one ITN, across all areas, due to malaria endemicity. The Lake endemic zone saw the most substantial decline, amounting to 13%, with a prevalence of 82% in 2015 decreasing to 69% in 2020(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021). The findings of this study indicate the presence of an existing gap that has to be addressed. To get complete coverage and use of ITN, implementing a comprehensive and well-designed plan is important. This research aimed to examine the use of insecticide-treated bed nets (ITNs) within households, and RTS,S uptake and to determine the occurrence of malaria infection when these two interventions are employed. The data presented demonstrated the significant demand for solutions to cover insecticide-treated nets comprehensively and the need for interventions for improved RTS, S coverage.

2.5 Conceptual Framework

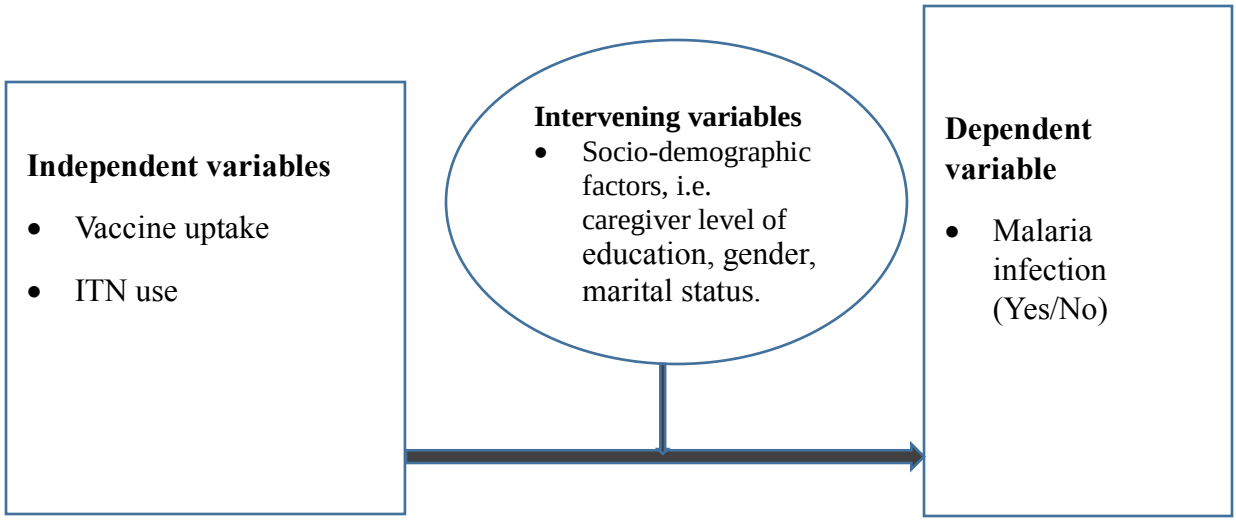

Figure 1. *Conceptual framework:* **Source (Literature review)**

Independent variables were RTS, S uptake, and ITN use. These are factors that directly influence malaria infection. Intervening variable influences the association between independent variable and dependent variable. The Caretaker's level of education, religious beliefs, gender, marital status, child's age, child's sex etc. The dependent variable was malaria infection which was the outcome being influenced by exposure.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Study Area

The research was conducted within the geographical area of the Muhoroni sub-county, located in Kisumu County. Kisumu County is classified as one of the 47 counties within the Republic of Kenya. It has a geographical area of about 2085.9 square kilometers and is inhabited by a population of 1,155,574 people. Kisumu County comprises seven sub-counties namely Muhoroni, Kisumu East, Kisumu Central, Nyakach, Nyando, Seme, and Kisumu West. Muhoroni is characterized by a mostly rural environment, with a total population of 154,116 individuals. Among this population, there are 76,770 males and 77,345 females. The geographical expanse of Muhoroni spans an area of 667.30 square kilometers. The location's geographical coordinates may be described as the latitude is 0° 09' 14.62" N, and the longitude is 35° 11' 55.61" E. The region consists of five administrative divisions, specifically referred to as wards, which are named as follows: Chemelil, Masogo/Nyangoma, Miwani, Ombeyi, and Muhoroni/Koru. The primary economic pursuits of the local populace include commerce and agriculture. The region under consideration exhibits a holoendemic concerning Malaria, indicating a high and constant transmission of the disease throughout the year. Research has shown a higher prevalence of malaria infection in rural regions than in urban areas. Muhoroni sub-county has a rural setup, malaria transmission is higher in rural settings in Kenya compared to urban. This might be caused by poor housing quality, poor drainage systems and a high number of vectors. Kisumu Central, Kisumu East and Muhoroni were the three sub-counties in Kisumu that were rolling out the malaria vaccine. Among the three, Kisumu

Central and East are in an urban setup with many migrations and movements, therefore unsuitable for this Study.

3.2. Research Design

This was a quantitative cross-sectional study. Structured questionnaires and data abstraction were used to collect data on malaria vaccine and ITN uptake.

3.3. Population

The target population included 13,503 caregivers of children 6 to 36 months in Muhoroni sub-county, out of these, 319 were sampled for the study. Demographic information of these caregivers was collected with social, economic and cultural information.

3.4. Inclusion and exclusion criteria

All caretakers of children 6-36 months in Muhoroni sub-county were included in the study. Caretakers not residing in Muhoroni subcounty were excluded as well as eligible caretakers who refused to consent.

3.5 Sample size determination

The sample size was calculated using the Cochran formula, as shown below.

$$N = \frac{Z^2(p)(q)}{e^2}$$

Where

$N_=$ Sample size

Z=Standard normal variant for margin of error

p= proportion of malaria prevalence in lake endemic zone in Kenya

q=1-p

e=margin of error

Kisumu County is in the Lake endemic zone with a malaria proportion of 27% (Malaria Indicator Survey 2015); we, therefore used a 95% confidence interval, 27% proportion, a margin of error of 5% and a 5% adjustment for nonresponse.

(1.96)2*0.27(1-0.27)/ (0.05)2= 302.87.

So the Study had a sample size of 303+16 (5% of sample size for nonresponse) =319. 5% is the estimated rate of non-response from the studies done in this area.

3.6. Sampling procedure

Community Health Volunteers provided 13,502 mapping data of children 6 to 36 months in the households they cover. Children were then stratified as per the 41 community unit they come from, simple random sampling method using excel was used to select children from each stratum based on the number eligible per strata to give a total of 319 children. Caretakers of the 319 children were then visited in their households with the guide of 41 CHVs to be enrolled in the Study.

3.7. Data collection procedure

Interviews were administered to eligible caretakers using a structured questionnaire on the Open Data Kit tool (ODK). After getting the sampled caretakers and their children, the CHV was therefore given the list of all the households to be visited in her/his CU for mobilization a week to the visit. On the visiting week, the CHV was taking the research officers to the households they had mobilized and planned to be visited on that particular day and time. After introduction by the CHV, the RA went ahead to consent the respondent after confirming that he/she is the right respondent, and the interview location is conducive. The written consent was administered using a language that the respondent understood well, where the respondent was illiterate, the respondent would look for a

witness to be present during the process. In cases of refusal, the research assistant would thank the respondent and walk away, if the respondent agreed to take part in the study, then the RA would consent and proceed to administer a structured questionnaire. Uptake of RTS, S vaccine information was abstracted from the MCH booklet. Occurrence of malaria infections was obtained from a review of hospital books in the household and the MCH booklet where the diagnosis is normally recorded.

3.8. Validity and Reliability of the data collection tools.

The questionnaires were given to research scientists and statisticians to review and critique. The professional comments and subsequent amendments were important to establish the instrument's content validity. A final version of the questionnaire was then developed and used for data collection.

The reliability and Validity of the tools was tested using a pilot test. Before commencing the real data-collecting process, a pilot test was done in Kisumu east sub-county to evaluate the reliability and validity of the questionnaire. This test aimed to prepare research assistants for the data collection phase and examine and enhance the effectiveness of the research instruments. Reliability was established using a test-retest approach, including a sample size of 32 respondents accounting for 10% of the research sample. Subsequently, reliability coefficients were obtained. The findings from the administered structured questionnaire indicate a high-reliability coefficient of 0.821, above the minimal criterion of 0.70. This suggests that the questionnaire demonstrates a satisfactory level of dependability. The challenges during the pretesting sessions were thoroughly examined and addressed during subsequent debriefing meetings. As a result of these discussions, relevant modifications were made to the questionnaires as required.

The questionnaires were administered to participants as part of the pretest investigation, during which feedback and recommendations gathered from the pretesting phase were used to enhance the instrument. The questions that lacked clarity in the tool were rephrased to enhance their clarity.

3.9. Data Management

A 3-day intensive training was done for five research officers before data Collection. The training consisted of going through the protocol to discuss the Study's purpose, objectives and goal, community entry, creating rapport, study procedures, collection of quality data and adherence to ethics in every activity.The ODK software was used for the digital input of data, facilitating data validation and quality assurance throughout the data entry stage.

3.10. Data Analysis

Objectives 1&2- Descriptive statistics were used to describe the RTS, S vaccine uptake, ITN, use and occurrence of malaria infections. The same was used to describe the caregiver's socio-demographic socioeconomic, educational status, marital status, religious/cultural information, vaccine knowledge, and distance to the nearest facility.

Objectives 3 & 4-Inferential statistics, in particular, Chi squire test of association and regression analysis were used to establish the association of malaria preventive measures on the occurrence of malaria infections. STATA Version 16 was used for analysis. Data was presented in terms of tables and graphs.

3.11. Ethical Considerations

Approval to conduct this study was obtained from the Board of Post Graduate Studies of (JOOUST), the ethical review board of JOOUST, and NACOSTI. We sort permission from relevant authorities, including MOH Kisumu County by way of a copy of the

research authorization letter before the start of data collection. An acceptance letter was then received from the Kisumu County director of public health and sanitation to proceed with data collection. The letter was copied to Muhoroni and Kisumu East MOH where permission was granted for the study to take place. Research assistants were trained on study protocol and necessary skills, i.e. communication skills such as clarity, audibility, interpersonal skills and various ethical standards such as confidentiality, respect to human subject, justice, benevolence, non-maleficence and data quality. The Study considered the respondents' confidentiality, anonymity, and privacy and ensured that the communities in the study area were not negatively affected by the survey.

3.12. Data Storage/Archiving and Destruction

The data collected was cleaned, entered and stored in a computer well-protected with a complex password to reduce accessibility by unauthorized persons. The hard copy questionnaires were stored in a lockable drawer until six months after publishing the study findings after-which, the raw data was destroyed by shredding the data collection tool.

CHAPTER FOUR: RESULTS

4.1 Socio-Demographic Characteristic

A total of 319 caretakers were recruited in the study, and the majority (50%) fell in the age category of 17-29 years.93.1% of the caretakers were female, and 86.21 were married. 58.93% of the caretakers had primary education, followed by secondary (32.6), Tertiary (6.9), and 1.57% never attended school. All the participants except one were Christians. More than half of the caretakers (50.78) used less than 30 minutes to reach the nearest health facility. Table 4.1.1pg26

A total of 319 children aged 6-36 months (male=126, female=139) were enrolled in the study, having been grouped in the age category of 0-6months 2.82%(9),7-8months 3.76%(12),9-23months 35.42%(113) and 24-36months 57.99%(185). Table 4.1.2pg 26

Table 4.1.1: *Socio-demographic factors of caretakers*

Category	Group	Frequency	%
Age	>17 to <=29yrs	160	50.16
	>=30 to<=42yrs	127	39.81
	>=43 to <=55yrs	23	7.21
	>=56 to <=68yrs	5	1.57
	>68yrs	4	1.25
Sex	Female	297	93.1
	Male	22	6.9
Marital status	In marriage	275	86.21
	Not in marriage	44	13.79
Education	Primary	188	58.93
	Secondary	104	32.6
	Tertiary	22	6.9
Religion	Christian	318	99.69
	Muslim	1	0.31
Time is taken to reach Health Centre in min	0-30	162	50.78
	31-60	133	41.69
	61-90	11	3.45
	91-120	11	3.45
	120-150	1	0.31
	151 and above	1	0.31

Distribution of the frequencies and percentages of the demographic characteristics of caretakers.

Table 4.1.2: *Socio-demographic factors of children*

Age in months	0-6	9	2.82
	7-8	12	3.76
	9-23	113	35.42
	24-36	185	57.99
Sex	Female	161	50.47
	Male	158	49.53

Distribution of the frequencies and percentages of the demographic characteristics of children.

4.2. Occurrence of Malaria Infection

About 33% of children within the age category0-6 months were malaria positive; none in the age of 7-8 months were positive although the number was only 7; about 40% in the age of 9-23 were positive, and finally, 78% were positive among age category of 24-36. Table 4.2.1 and Figure 4.2.1pg 27.

Table 4.2.1: *Occurrence of malaria infection*

Age of the child	**Diagnosis results**		
Category (months)	**Negative n(%)**	**Positive n(%)**	**Total n(%)**
0-6	4(66.67)	2(33.33)	6(100)
7-8	7(100)	0(0)	7(100)
9 -23	25(39.06)	39(60.94)	64(100)
24-36	24(22.22)	84(77.78)	162(100)
Total	**60(32.43)**	**125(67.57)**	**185(100)**

Figure 4.2.1 shows the distribution of malaria infection observed in the last six months. The infection was common among the aged 23-36 months old (78%).

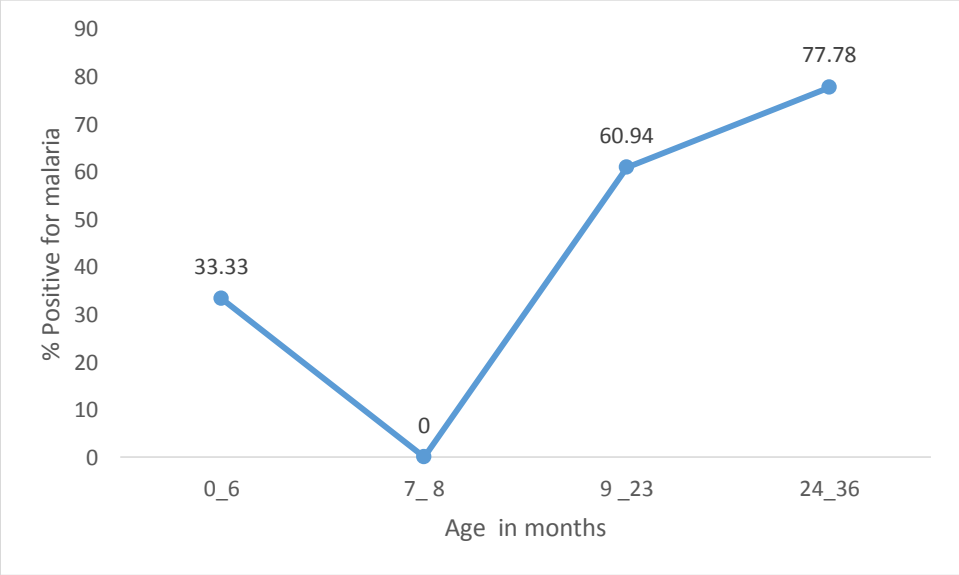

Figure 4.2.1: *Distribution of malaria infection per age group*

Distribution of malaria infection per age group. 24-36months had the highest malaria prevalence

4.3. Uptake of Malaria Prevention Measures.

4.3.1. RTS, S Vaccine

Malaria vaccine uptake for dose 1 was 72%, the second dose was 67%, the third dose was 59%, and the fourth dose uptake was 31%. Of children who received at least one dose of the RTS S vaccine, 73%, and among them, only 60% received the recommended dose according to their ages. Table 4.3.1.1pg28

Table 4.3.1.1: *Uptake of RTS, S vaccine*

	Category	**n**	**N**	**%**
RTS, S 1	No	89	319	27.9
	Yes	230	319	72.1
RTS, S 2	No	103	310	33.22
	Yes	207	310	66.78
RTS, S 3	No	121	298	40.6
	Yes	177	298	59.4
RTS, S 4	No	127	185	68.65
	Yes	58	185	31.35
At least 1RTS, S dose	No	86	319	26.96
	Yes	233	319	73.04
Receive recommended dose	No	93	233	39.91
	Yes	140	233	60.09

The table shows the percentage uptake of the four doses of the malaria vaccine and the percentage of children who received the recommended dose and those who just received at least one dose.

4.3.1.2. RTS, S uptake per dose.

Uptake of RTS, S was as follows, first dose had 72.10% uptake, the 2nd had 66.68%, the 3rd had 59.40%, and the last one had 31.35%, respectively. Figure 4.3.1pg29.

Figure 4.3.1. *Uptake of RTS, S vaccine dose from the first one to the fourth one*.

The error bar represents the standard error

4.3.2. ITN usage

Among 319 households visited, 306(96%) had at least one bed net, with 13 having no ITN bed net. In the 319 households, only 100(31%) had universal net coverage (at least one net for two people), with 69% not having universal access. Among 319 children, 283(88.71) slept under a bed net the night before the interview. Tables 4.3.2.1, Table 4.3.2.2 and Table 4.3.2.3 pg30.

Table 4.3.2.1: *ITN Usage*

	Category	n	N	%
Own at least one bed net	No	13	319	4.08
	Yes	306	319	95.92
Universal net coverage	No	219	319	68.65
	Yes	100	319	31.35
ITN usage last night	No	32	319	10.03
	Yes	283	319	88.71
	Don't Know	4	319	1.25

The table shows ITN usage on the night to the data collection and ITN ownership per household.

Table 4.3.2.2: *The number of children who slept under mosquitos net a night to the interview.*

Age of child in months	ITN usage per age n(%)		
Category	Yes	No	Total
0-6	8(88.89)	1(11.11)	9
7-8	11(91.67)	1(8.33)	12
9-23	100(88.50)	13(11.50)	113
24-36	164(88.65)	21(11.29)	185
Total	**283(88.71)**	**36(11.29)**	**319(100)**

Usage of ITN a night to the interview. This was grouped per age group.

Table 4.3.2.3: *Households with at least one-bed net for two people*

Age of the child	Universal net coverage		
Category	**NO (n)**	**YES (n)**	**Total (n)**
0-6	2(22.2)	7(77.78)	9(100)
7-8	7(58.33)	5(41.67)	12(100)
9 -23	77(68.14)	36(31.86)	113(100)
24-36	133(71.89)	52(28.11)	185(100)
Total	**219(68.65)**	**100(31.35)**	**319(100)**

Households owning at least one ITN for two people.

4.4 Association of malaria prevention measures on malaria occurrence.

Bivariate logistic regression was done on every variable in the prevention measures that have statistical significance (RTS, S 1, RTS, S 2, RTS, S 3, RTS, S 4, Receiving recommended dose of RTS, S, receiving at least a dose of RTS, S vaccine, a child sleeping under a bed net last night, a household having universal net coverage and a household owning at least one-bed net) were tested for association.

Receiving the recommended dose (COR 5.87, 95% CI 2.25-15.31, P=<0.001), sleeping under mosquito nets (COR 6.20, 95% CI 1.41-27.29, P=0.016), receiving at least one RTS, S dose (COR 2.72, 95% CI 1.26-5.88, P=0.011) and Household universal net coverage (P=<0.041) showed level of statistical significance and were then tested in the multivariable logistic regression to test the association on malaria infection. Table8 pg32. Children who haven't received the recommended dose were six times more likely to get malaria infection as compared to a child who received all the recommended dose (COR 5.87, 95% CI 2.25-15.31, P=<0.001).

In addition, a child who had not received any dose of the RTS, S vaccine was three times more likely to get malaria infection than a child who had received any vaccine dose (COR 2.72, 95% CI 1.26-5.88, P=0.011). This showed that a child who had received all the doses they were eligible for is more protected than a child who has just received any dose without full compliance. A child who did not sleep under a mosquito bed net was six times more at risk of malaria infection than children who used a bed net (COR 6.20, 95% CI 1.41-27.29, P=<0.016). A child from a household that did not meet universal net

coverage was two times at risk of malaria infection compared to those whose households met universal net coverage (COR 1.95, 95% CI 1.03-3.68, P=<0.041). Table 4.4.1pg32.

Table 4.4.1: *Bivariate Logistic regression for the association between malaria occurrence and uptake of prevention measures.*

Test results	Response	n	N	%	95%CI	P value	crude Odds ratio	P value	95%CI
Received recommended RTS, S dose	Yes	45	89	50.56	40.15-60.93	<0.001	Ref		
	No	36	42	85.71	71.28-93.55		5.87	**<0.001**	2.25-15.31
Receive at least 1RTS, S dose	Yes	81	131	61.83	53.15-69.82	0.009	Ref		
	No	44	54	81.48	68.65-89.84		2.72	**0.011**	1.26-5.88
Slept under ITN last night	Yes	103	161	63.98	56.20-71.08	0.007	Ref		
	No	22	24	91.67	71.29-97.99		6.2	**0.016**	1.41-27.29
HH universal net coverage	Yes	37	64	57.81	45.31-69.39	0.039	Ref		
	No	88	121	72.73	64.02-79.98		1.95	**0.041**	1.03-3.68
HH ownership of at least a bed net	Yes	118	176	67.05	59.70-73.64	0.502	Ref		
	No	7	9	77.78	39.53-94.93		1.72	0.507	0.35-8.54

Association of RTS,S, and ITN on malaria vaccine.

4.5. Association between socio-demographic characteristics and malaria occurrence.

A Chi-square test revealed that only the child's age had statistical significance **(<0.001)** Table 4.5.1 pg33**.** Bivariate logistic regression of malaria infection and age was done. Table 4.6.1 pg34.

Table 4.5.1: *Distribution of malaria occurrence by socio-demographic characteristics.*

Test results	Cat	Prev	N	%	95% CI	P value
Child's age in months	0-6	2	6	33.33	7.14-76.47	**<0.001**
	7-8	0	7	0	0	
	9-23	39	64	60.94	48.38-72.20	
	24-36	84	108	77.78	68.87-84.70	
Sex of the child	Female	61	89	68.54	58.07-77.41	0.786
	Male	64	96	66.67	56.56-75.45	
Marital status of caretaker	In marriage	107	160	66.88	59.15-73.79	0.611
	Not in marriage	18	25	72	51.19-86.31	
Time is taken to health Centre in min	0-30	61	94	64.89	54.63-73.94	0.321
	31-60	49	75	65.33	53.79-75.32	
	61-90	7	7	100	.	
	91-120	6	7	85.71	37.52-98.36	
	120-150	1	1	100	.	
	151 and above	1	1	100	.	
Sex of caregiver	Female	116	173	67.05	59.64-73.70	0.57
	Male	9	12	75	43.16-92.22	
Age of the caretaker	>17 to <=29yrs	6	11	54.55	25.53-80.77	0.453
	>=30 to<=42yrs	107	160	66.88	59.15-73.79	
	>=43 to <=55yrs	9	10	90	50.13-98.77	
	>=56 to <=68yrs	2	3	66.67	9.40-97.47	
	>68yrs	1	1	100	.	
Education of the caregiver	None	4	4	100	.	0.326
	Primary	77	115	66.96	57.77-75.01	
	Secondary	39	56	69.64	56.26-80.36	
	tertiary	5	10	50	21.16-78.84	

Association of socio-demographic factors of caretakers and children on malaria infection

4.6. Association of age on malaria infection

A child in the age category of 9-23 is three times more likely to get malaria infection than a child in the age category of 0-6 months (COR 3.12,95%CI 0.53-18.32, P=0.21). A child in the age category of 24-36 months is seven times more likely to get malaria infection than a child in the age category of 0- 6 months (COR 7.00,95%CI 0.09-2.73, P=0.03). Table 4.6.1 pg34. Age was therefore tested in a multivariable logistic regression with the Recommended dose of RTS, S, and bed net usage the previous night**.**

Table 4.6.1: *Association of age and malaria infection.*

Test results	**Crude Odds ratio**	**P. value**	**95%CI**	
Age of the child				
9_23	3.12	0.208	.5313862	18.31888
24_36	7	0.03	.0915815	2.729808

Association of age of the child on malaria infection

4.7. Multivariable logistic regression

Statistically significant variables (P-value =0.05 or less) in bivariate regression analysis were further moved to multivariate logistic regression to measure the association.

Children who did not receive the recommended dose of RTS, S are 4.07 more likely to get malaria infection than their counterparts who received RTS, S as recommended [AOR=4.07, 95%CI=1.51-11.01, P=0.006]. A child who did not sleep under a mosquito net is 12 times more likely to get malaria infection than a child who slept under a bed net [AOR=11.61,95%CI=1.10-122.59, P=0.041]. With every increase in age, a child is two times at risk of getting malaria infection

compared to a younger one [AOR=2.22,95%CI=1.22-4.02, P=0.009]. This shows that age is a risk factor for malaria infection. See Table 4.7.1 pg35.

Table 4.7.1: *Multivariable logistic regression of Test results and multiple variables*

Category	**Response**	**AOR**	**95% CI**	**P>|z|**
Recommended RTS, S dose	Yes	Ref.	.	.
	No	4.07	1.51-11.01	**0.006**
ITN was used last night	Yes	Ref.	.	.
	No	11.61	1.10-122.59	**0.041**
Age of the child		2.22	1.22-4.02	**0.009**

Multiple logistic regression of statistical significant variables on malaria infection

CHAPTER FIVE. DISCUSSION OF FINDINGS.

5.1. Occurrence of Malaria Infection

The results showed an increase in malaria prevalence which was increasing as the age category increased, this finding is in agreement with a study done in Kisumu County which was modeling the trend of reported malaria cases in Kisumu County, Kenya. The study reported increasing incidents of malaria infection in the county(E. Achieng *et al.*, 2020). Due to the location of the Muhoroni sub-county within a lake endemic zone, the results of this study corroborate those of the Kenya Malaria Indicator Survey 2020 which reported a high prevalence of malaria infection in this area (Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021)

5.2. Uptake of RTS, S vaccine

The results have documented a notable deficiency in adopting the RTS, S malaria vaccine. It has shown a declining uptake of RTS,S vaccine with the subsequence doses moving from dose 1 to dose 4 (72.10% ,66.68%,59.40%, and 31.35%),none of the dose met WHO target of 90% uptake of all the doses(Tabiri *et al*., 2021).This study findings align with a previous investigation conducted in 2021 that examined the factors influencing the adoption of malaria vaccination in the Sunyani Municipality of Ghana. The mentioned study revealed a decline in the acceptance of the RTS, S vaccine as the number of doses administered increased. Specifically, the study reported uptake rates of 94.1%, 90.6%, and 78.1% for the first, second, and third doses, respectively. Notably, no data was collected regarding the uptake of the fourth dose (Tabiri **et al.,** 2021). The poor vaccine uptake was also noticed in a study done in the Western region of Kenya which examined the malaria vaccine coverage estimation using age-eligible populations and service user denomination. It revealed that overall, service-based malaria vaccine

coverage was 96%, 87%, 78%, and 39% for doses 1–4 respectively. Based on the population-derived denominator for age-eligible children, vaccine uptake was 78%, 68%, 57%, and 24% for doses 1–4, respectively(Moturi *et al*., 2023).

The findings of this study indicate a deficiency in adopting routine malaria vaccine uptake for the 4 doses, the study observation aligns with research conducted in 2014, which examined the adoption of a malaria vaccination among caregivers of ill children in Kenya. One of the identified factors contributing to the poor uptake of the malaria vaccine was the limited availability of vaccine-related information (Ojakaa *et al*., 2014). The findings of this study align with those of a previous study conducted on the present obstacles and suggested remedies for the successful execution of the RTS, S/ AS01 Malaria Vaccine Program in sub-Saharan Africa. As mentioned above, the study identified insufficient community involvement resulting from limited knowledge about the vaccine and concerns regarding its potential adverse effects as the primary factors contributing to the low adoption of RTS S (Dimala *et al*., 2018).

5.3. ITN usage

This study reported 89% of bed net use by children 6-36 months a night before the interview. This study is in agreement with KMIS 2020 which revealed that ITN use among children under age 5 in households with at least one ITN increased from 71% in 2010 to 79% in 2015 and then decreased to 72% in 2020 (President & Initiative, 2019), The result again showed that 31% of households had a universal net coverage (At least one net for two people). This result is in agreement with KMIS 2020, which showed a universal net coverage of 31% in 2020(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021), there is a slight increment in this study(2%), and this

could be because of the routine bed net distribution by President Malaria Initiative(PMI) when a woman is pregnant and Child Welfare Clinic(CWC) program which gives ITN to children less than one year when they go for postnatal clinic and again a mass ITN distribution program that happens after every three years(President & Initiative, 2019).

This study did not meet the PMI goal of having all the households attain universal net coverage (at least one-bed net for two people) (World Health Organization, 2016). 96% of the household had at least one ITN. This result agrees with KMIS 2015, which showed that by endemicity, 88.2% of the lake endemic zone households have at least one-bed net(MOH, 2016). There is a slight increment in our results (8%), and this is because of the routine bed net distribution by President Malaria Initiative(PMI) when a woman is pregnant and the Child Welfare Clinic(CWC) program, which gives ITN to children less than one year when they go for postnatal clinic and again a mass ITN distribution program that happens after every three years(President & Initiative, 2019)(MOH, 2016)(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021). Since my population was children 6-36 months, ownership of the bed net must be high because of the support of these three programs.

The ITN usage decreased with increasing age (see Table 4.3.2). This result is in agreement with KMIS 2020 which revealed that ITN use among children decreases with increasing age, from 48% among those less than age 12 months to 34% among those aged 48-59 months(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021)

5.4 Association of RTS, S uptake, and ITN use on malaria infection.

RTS, S has helped reduce malaria infection, malaria prevalence was higher in children who did not receive the recommended dose as compared to those who received full

recommended doses. These results agree with the results from a pilot introduction of the vaccine by WHO in Kenya, Ghana, and Malawi, which showed a substantial reduction in deadly severe malaria, a drop in child hospitalizations, and a reduction in child deaths (Narain *et al*., 2022). This study is unique in showing the level of vaccine compliance per age category in the community. Many studies have shown low uptake of RTS, S vaccine. However, little has been shown on the level of vaccine compliance based on the age eligibility criteria and the effect the compliance has on malaria infection. Many studies have been done on the uptake of the RTS and S vaccine, especially on the 1^{st},$2^{nd,}$ and 3^{rd} vaccines, but very little has been studied on the 4^{th} dose uptake. This study looked at the RTS, S uptake from the 1^{st} to the 4^{th} dose at two years.

This study showed that a child who did not sleep under a mosquito bed net was six times more at risk of malaria infection than children who used a bed net. It goes ahead to show that a child from a household that did not meet universal net coverage was two times at risk of malaria infection compared to those whose households met universal net coverage. This study shows that ITN has a positive association with malaria infection as malaria prevalence is seen to be high in children that doesn't use ITN. The report from Kenya Indicator Survey showed a similar results while looking at ITN coverage and malaria prevalence among children(Division of National Malaria Programme (DNMP) [Kenya] & ICF, 2021).

The findings indicate a positive correlation between age and malaria infection in children, aligning with the findings of the Kenya Malaria Indicator Survey which reported an increase in malaria prevalence with age based on microscopy analysis (Division of National Malaria Programme [DNMP] [Kenya] & ICF, 2021). This observation is

consistent with a study conducted in Ghana that examined the relationship between malaria and anemia in children from two communities in Kumasi, which identified age as a contributing factor to malaria infection (Ronald *et al.,* 2006). This research aligns closely with a previous investigation that examined the prevalence and risk factors associated with malaria, anemia, and malnutrition among children living in internally displaced persons (IDP) camps in Edo State, Nigeria. According to this study, it was observed that there is a positive correlation between age and susceptibility to malaria in children (Ajakaye & Ibukunoluwa, 2020). The study examined the correlation between the malaria status of children under five and various household demographic, socioeconomic, and environmental factors associated with the disease in Sierra Leone. Additionally, the study identified age as a significant factor associated with malaria infection, which aligns with the findings of a previous study conducted in Sierra Leone(Bah, 2020).

This study had limitations in that it was done in a single place (Muhoroni sub-county) and hence may not represent the real situation in other parts of western Kenya. This study measured the occurrence of malaria infection for the past six months, this may cause some level of bias. This is because, much as health records were used, some of the responses were based on maternal recall since no health records were available. Some age categories had a very small number of samples, i.e. 0-6 and 7-8 months, this might not give a true representation of a bigger population.

CHAPTER SIX. CONCLUSION AND RECOMMENDATIONS.

6.1. Conclusions

Having analyzed the data collected from the sampled population, the researcher made conclusions that there is a high prevalence of malaria infection in Muhoroni sub-county. There is poor uptake of RTS, S malaria vaccine as the lowest consumed being dose 4 followed by dose 3,2 and finally the first one being the one with the highest uptake. The uptake level decreases as a child grows. ITN usage in Muhoroni sub-county is high with very few children not sleeping under ITN, full universal net coverage is not met in Muhoroni sub-county. RTS,S uptake, and ITN use have a positive association on malaria infection. The two interventions reduce the prevalence of malaria infection. Age is a risk factor in RTS,S uptake, ITN use, and malaria infection.

6.2 Recommendations for practice

a. The study recommended more interventions, partnerships, and support from various stakeholders to help reduce malaria prevalence in children in the Muhoroni sub-county.
b. Based on the first objective on uptake of RTS,S, the study recommends health education targeting caretakers and the public at large with the engagement of CHVs and other stakeholders to sensitive them to the importance of malaria vaccine and the need for full dose coverage.
c. On the uptake of ITN, to ensure that each child sleeps under ITN and each household has universal net coverage, there should be interventions and proper plans to replace worn-out bed nets in good time, and there should be proper data collection with the help of CHVs on the number of people living in the household

before ITN distributions and a routine household check by CHVs in case a household increases in size for an additional bed net. Health education is essential too to enlighten the public on the importance of sleeping under ITN. This needs adequate support and coordination from stakeholders.

d. On the association of RTS,S, and ITN on malaria infection, the study recommended more interventions to help boost the uptake of the two interventions for the reduction of malaria prevalence.

6.3. Recommendation for future study

a. Future studies should come up with additional interventions on how to optimized the use of existing malaria prevention interventions in order to reduce the prevalence of malaria in children in Muhoroni Sub-county.
b. Future studies should identify reasons for low uptake of RTS,S vaccine.
c. Future studies should evaluate and come up with possible interventions for improving the RTS,s coverage and universal ITN coverage.

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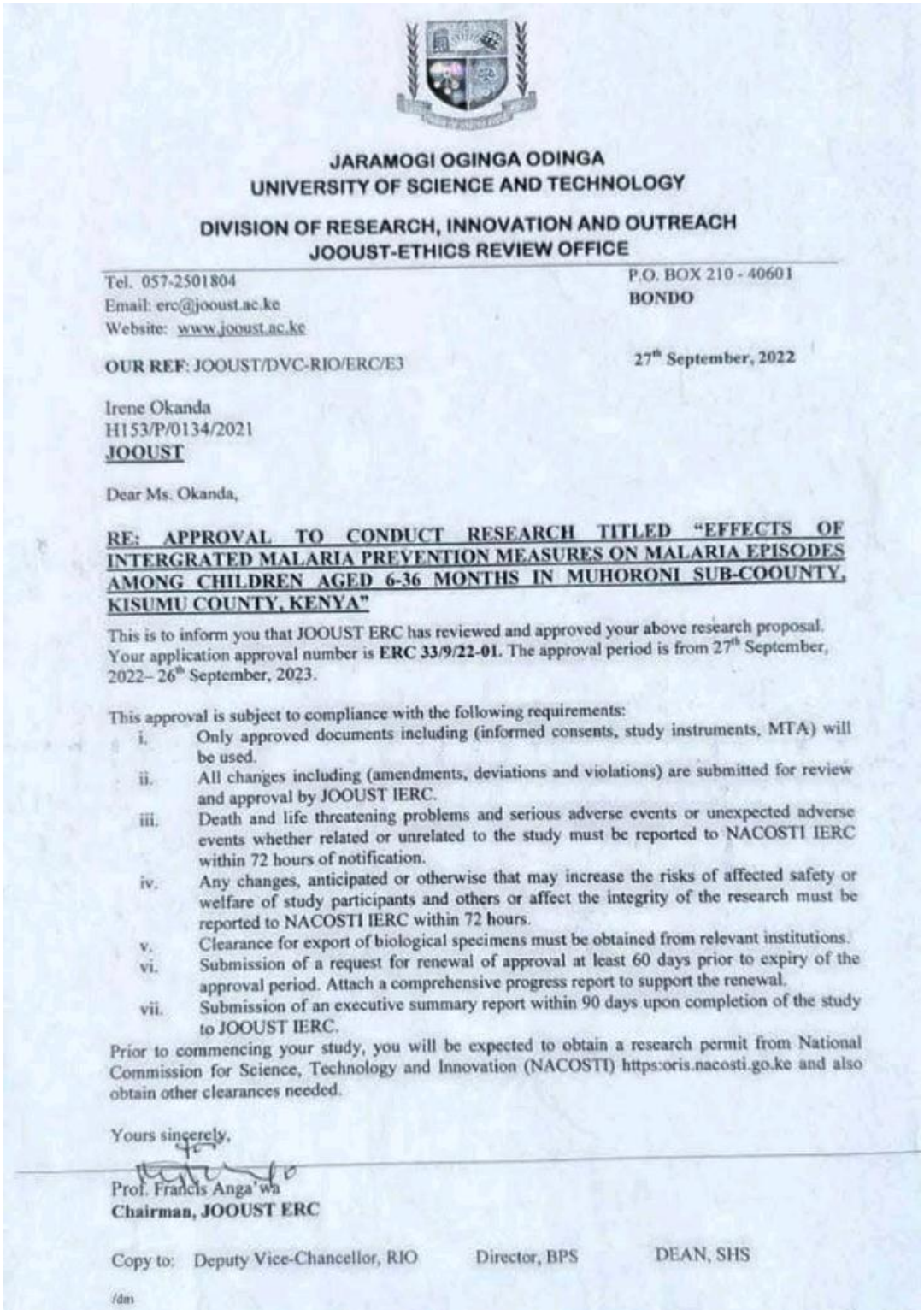
APPENDICES

Appendix 1: Ethical approvals



JARAMOGI OGINGA ODINGA
UNIVERSITY OF SCIENCE AND TECHNOLOGY

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JOOUST-ETHICS REVIEW OFFICE

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BONDO

OUR REF: JOOUST/DVC-RIO/ERC/E3

27th September, 2022

Irene Okanda
H153/P/0134/2021
JOOUST

Dear Ms. Okanda,

RE: APPROVAL TO CONDUCT RESEARCH TITLED "EFFECTS OF INTERGRATED MALARIA PREVENTION MEASURES ON MALARIA EPISODES AMONG CHILDREN AGED 6-36 MONTHS IN MUHORONI SUB-COOUNTY, KISUMU COUNTY, KENYA"

This is to inform you that JOOUST ERC has reviewed and approved your above research proposal. Your application approval number is **ERC 33/9/22-01.** The approval period is from 27th September, 2022– 26th September, 2023.

This approval is subject to compliance with the following requirements:

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations and violations) are submitted for review and approval by JOOUST IERC.
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to NACOSTI IERC within 72 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks of affected safety or welfare of study participants and others or affect the integrity of the research must be reported to NACOSTI IERC within 72 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to JOOUST IERC.

Prior to commencing your study, you will be expected to obtain a research permit from National Commission for Science, Technology and Innovation (NACOSTI) https:oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely,

Prof. Francis Anga'wa
Chairman, JOOUST ERC

Copy to: Deputy Vice-Chancellor, RIO Director, BPS DEAN, SHS

/dm

JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE & TECHNOLOGY

BOARD OF POSTGRADUATE STUDIES
Office of the Director

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P.O. BOX 210 - 40601
BONDO

Our Ref: H153/P/0134/2021

Date: 7th Sept 2022

TO WHOM IT MAY CONCERN

RE: OKANDA IRINE ADHIAMBO - H153/P/0134/2021

The above person is a bonafide postgraduate student of Jaramogi Oginga Odinga University of Science and Technology in the School of Health Sciences pursuing Master of Science in Epidemiology and Biostatistics. She has been authorized by the University to undertake research on the topic: ***"Effects of Intergrated Malaria Prevention Measures on Malaria Episodes among Children Aged 6-36 Months in Muhoroni Sub-County,Kisumu County, Kenya".***

Any assistance accorded her shall be appreciated.

Thank you.

SEP 2022

Prof. Dennis Ochuodho
DIRECTOR, BOARD OF POSTGRADUATE STUDIES

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **529996**

Date of Issue: **19/October/2022**

RESEARCH LICENSE

This is to Certify that Miss.. Irine Adhiambo Okanda of Jaramogi Oginga Odinga University of Science and Technology, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kisumu on the topic: EFFECTS OF INTEGRATED MALARIA PREVENTION MEASURES ON MALARIA EPISODES AMONG CHILDREN AGED 6-36 MONTHS IN MUHORONI SUB-COUNTY, KISUMU COUNTY, KENYA. for the period ending : 19/October/2023.

License No: **NACOSTI/P/22/20843**

529996

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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See overleaf for conditions

THE SCIENCE, TECHNOLOGY AND INNOVATION ACT, 2013 (Rev. 2014)

Legal Notice No. 108: The Science, Technology and Innovation (Research Licensing) Regulations, 2014

The National Commission for Science, Technology and Innovation, hereafter referred to as the Commission, was the established under the Science, Technology and Innovation Act 2013 (Revised 2014) herein after referred to as the Act. The objective of the Commission shall be to regulate and assure quality in the science, technology and innovation sector and advise the Government in matters related thereto.

CONDITIONS OF THE RESEARCH LICENSE

1. The License is granted subject to provisions of the Constitution of Kenya, the Science, Technology and Innovation Act, and other relevant laws, policies and regulations. Accordingly, the licensee shall adhere to such procedures, standards, code of ethics and guidelines as may be prescribed by regulations made under the Act, or prescribed by provisions of International treaties of which Kenya is a signatory to
2. The research and its related activities as well as outcomes shall be beneficial to the country and shall not in any way;
    i. Endanger national security
    ii. Adversely affect the lives of Kenyans
    iii. Be in contravention of Kenya's international obligations including Biological Weapons Convention (BWC), Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Chemical, Biological, Radiological and Nuclear (CBRN).
    iv. Result in exploitation of intellectual property rights of communities in Kenya
    v. Adversely affect the environment
    vi. Adversely affect the rights of communities
    vii. Endanger public safety and national cohesion
    viii. Plagiarize someone else's work
3. The License is valid for the proposed research, location and specified period.
4. The license any rights thereunder are non-transferable
5. The Commission reserves the right to cancel the research at any time during the research period if in the opinion of the Commission the research is not implemented in conformity with the provisions of the Act or any other written law.
6. The Licensee shall inform the relevant County Director of Education, County Commissioner and County Governor before commencement of the research.
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9. The Commission may monitor and evaluate the licensed research project for the purpose of assessing and evaluating compliance with the conditions of the License.
10. The Licensee shall submit one hard copy, and upload a soft copy of their final report (thesis) onto a platform designated by the Commission within one year of completion of the research.
11. The Commission reserves the right to modify the conditions of the License including cancellation without prior notice.
12. Research, findings and information regarding research systems shall be stored or disseminated, utilized or applied in such a manner as may be prescribed by the Commission from time to time.
13. The Licensee shall disclose to the Commission, the relevant Institutional Scientific and Ethical Review Committee, and the relevant national agencies any inventions and discoveries that are of National strategic importance.
14. The Commission shall have powers to acquire from any person the right in, or to, any scientific innovation, invention or patent of strategic importance to the country.
15. Relevant Institutional Scientific and Ethical Review Committee shall monitor and evaluate the research periodically, and make a report of its findings to the Commission for necessary action.

National Commission for Science, Technology and Innovation(NACOSTI),
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REPUBLIC OF KENYA

COUNTY GOVERNMENT OF KISUMU

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Director of Public Health, Preventive/
Promotion and Environmental Health
P.O. Box 721 – 40100,
Kisumu.

DEPARTMENT OF HEALTH & SANITATION

Our Ref: GN 133 VOL. XII/(500) **Date:** 13th January, 2023

To:

SCMOH – Muhoroni and Kisumu East

RE: AUTHORITY TO COLLECT DATA IN MUHORONI SUB COUNTY

This is to inform your office that **Irene Adhiambo Okanda**, a student at **Jaramogi Oginga Odinga University of Science and Technology (JOOUST)** pursuing **Masters in epidemiology and Biostatistics** has been permitted to carry out data collection in your Sub County.

On the same note she has also been permitted to conduct a one day Pilot test in **Kisumu East Sub County** in order to validate her tools by checking their reliability and validity.

Kindly accord her all the necessary support.

Regards

COUNTY DIRECTOR
OF HEALTH
KISUMU

Lilyana Dayo
Ag. Director - Public Health, Preventive/Promotion and Environmental Health
Kisumu County

APPENDIX 2: . Informed consent form

Introduction

Hello. My name is ……..……... I am a student at Jaramogi Oginga Odinga University of Science and Technology. I am studying the effects of integrated malaria prevention measures on malaria episodes among children aged 6-36 months in the Muhoroni sub-county, Kisumu County, Kenya. I am doing this study as part of the requirements of the Master's degree course I am pursuing at JOOUST. I am commissioned to conduct this study to understand the community's current malaria situation better and identify various prevention measures. This information will inform the Ministry of Health and the public about malaria vaccine uptake and ITN use, the effect of the RTS, S vaccine, and ITN on episodes of malaria in Muhoroni sub-county, Kisumu County. Your household was selected for this study because it has a child/children between 6-36 months of age. I want to ask some questions about you, your household, Vaccine information, episodes of malaria and care sought, and malaria control measures used. I will also ask to see the vaccination card of your child and treatment record and take its photograph so we can check the kind and dates vaccines were received and the kind of treatment received when your child had malaria. I will also request that you visit the care hospital to get your child's vaccination information in case the MCH booklet is unavailable. This will take about 30 to 60 minutes.

Benefits of the Study-There will be no direct benefits to you/your child, but the information gathered will help to inform policymakers and the public about the Malaria vaccine and other Malaria preventive interventions and also to inform MOH about the current malaria burden in this area.

Risks of the study -You might feel uncomfortable answering some questions, but you are free not to answer any question you might not want to answer.

Duration of the study-Your participation is needed just once (Today).

Confidentiality-The information that we collect from this study will be kept in a password-locked computer and will not be accessed by non-authorized people. Information about your child will be kept safely, and no one but the researchers will be able to see it. Any information about your household will be treated with much privacy. It will not be shared with or given to anyone except the researcher.

Sharing of the results-The knowledge that we get from this study will be shared through the University and EDCTP before sharing it with the public. We will not share personal information, including people's names. Afterwards, we will publish the results so that other people may learn from this research.

Right to refuse or withdraw-Your participation is voluntary; you may decide to participate or not. There will not be any harm to you or your baby if you decline to participate, but we hope you will agree to answer the questions since your views and experiences are important. If I ask you any question you do not want to answer, just let me know, and I will go on to the next question. You can stop the interview at any time.

Contact persons-In case you have any questions, you can contact the following study Principal investigators: Irine Okanda, student Jooust P.O. Box 1578, Kisumu. Tel 0718916978. Dr. George Ayodo, Co PI, Jooust Tel 0712176738. Dr Erick Okuto Co-PI, Jooust Tel 0736334274, JOOUST Ethics and Review Board P.O. Box 210 - 40601 Bondo – Kenya. Telephone: 057 – 2022575, E-Mail: kisumu@jooust.ac.ke

Do you have any questions? Do you agree to participate? If yes, kindly provide your details below.

Caregiver :	Name…….	Signature/Thumbprint	Date.
Witness:	Name…….	Signature	Date.
Researcher:	Name……..	signature	Date.

APPENDIX 2: Research Semi-Structured Questionnaire.

Title: Effects of integrated malaria prevention measures on malaria episodes among children aged 6-36 months in Muhoroni sub-county, Kisumu county, Kenya.

SECTIONS.

SECTION A: Socio-demographic characteristics of the caregiver

SECTION B: Malaria episodes.

SECTION C: Malaria prevention measures (RTSS, ITN, Early diagnosis and treatment).

SECTION D: Uptake of RTSS.

SECTION A: SOCIODEMOGRAPHIC CHARACTERISTICS OF THE CAREGIVER

Bio-Data (Caregiver)

1. Caregiver name [First……Middle……Last……]
2. Gender of the caregiver [Male] [Female]
3. Name of the child [First……Middle……Last…….]
4. Gender of the child [Male] [Female]
5. Age of respondent in years-
6. Age of the child in months [……...]
7. Marital status of the respondent [Married] [Single] [Separated] [Divorced] [Widower/Widower]
8. Caregiver level of education [University] [College] [Secondary] [Primary] [None]
9. Religion of the caregiver [Christian] [Muslim] [Hindu] [Pagan] [Other] (Specify)
10. Occupation of the caregiver [Employed] [business] [Farmer] [Unemployed]
11. Number of people living in the household [……]
12. Number of living under-five children in the household [Male] [Female]
13. Caregivers monthly income […….]
14. If married, spouse monthly income [……..…]
15. How many minutes do you need to reach the nearest health Centre?
16. House structure. [Mud] [Semi-permanent] [Permanent]

SECTION B: MALARIA OCCURRENCE.

1. Has (child's name) visited a health facility for the past 6 months? [Yes] [No]

2. Has your child ever been diagnosed with malaria? [Yes] [No]

3. Has your child been diagnosed with malaria in the past 6months? [Yes] [No]

4. If yes, where was the diagnosis done? [Public Health facility] [Private health facility] [Pharmacy] [CHV] [other……. specify]

5. Do you have a medical record book for the diagnosis? [Yes] [No] (If yes, Record information date, last episode).

6. Did you get antimalarial medication for your child? [Yes] [No]

7. If no, give reason [……..……]

8. If yes, which antimalarial did he/she use? [A.L.] [Quinine] [Duocotexine] [Herbal medicine] [D.K.]

9. How many days did the medication take? [……]

10. Did the child Complete medication [Yes] [No]

11. If no, give reason [……]

SECTION C: PREVENTIVE MEASURES (RTS, S, ITN).

1. How do our children contract malaria infection? [Bites by mosquitoes] [Cold weather] [Rain] [Others, specify]

2. How do we prevent/Control malaria in children? (Tick where necessary) [Malaria vaccine] [Insecticide treated nets] [Indoor residual Spraying] [Early diagnosis and treatment] [Other specify] […….]

3. Do your household use any malaria prevention measure? [Yes] [No]

If no, give reason [……..]

4. If yes, specify. (…….)

5. In your opinion, which malaria prevention measures work best for you?

5. Do your household own a mosquito bed net? [Yes] [No]

If not, why? [……]

6. If yes, how many? […….]

7. Did [the child] sleep under a mosquito bed net last night? [Yes] [No]

8. If no, why?

8. What is the condition of the net? [torn] [not torn] -

SECTION D: UPTAKE OF RTSS.

1. Have you ever heard of a malaria vaccine? [Yes] [No] (Explain to the respondent what RTS, S is)

2. If yes, how did you know about it?

[Mass media]

[Social media]

[CHV in the community]

[Health promotion/ education campaign]

[Health facility service provider]

[Others-specify] [……]

3. Where is it given? [Hospital/health facility]

[Pharmacy]

[School]

[D.K.]

[Others, specify] [……]

4. How is it administered?

[Orally]

[Injection]

[D.K.]

Others, specify […….]

5. How many doses of malaria should a child receive? Put doses and date?

(Put number)

[D.K.]

7. Can the malaria vaccine prevent your child from getting malaria? [Yes] [No] Give reason [……..]

8. After your child is vaccinated, do you think it is still necessary for your child to continue using other malaria preventive measures?

[Yes]

[No]

9. If no, give reasons […….]

10. Do you have MCH booklet?

[Yes]

[No]

(If yes, ask to see the MCH booklet and record RTS, S vaccine information).

1. Has your child received a malaria vaccine?

[Yes]

[No]

12. If no, why? […….]

13. If yes, how many doses has your child received- (Check the booklet) (Tick all that apply and add dates)

[Dose 1]

[Dose 2]

[Dose 3]

[Dose 4]

(If no book, use maternal recall)

15. Has the child received recommended doses? (do not ask, calculate)

[Yes]

[No]

16. If no, in your opinion, why has your child yet to receive the full recommended dose?

17. Was there any side effect of the vaccine in the fast three days after vaccination? [Yes]

[No]

If yes, which ones? [……..]

18. If yes, to what magnitude was the effect?

[Mild]

[Moderate]

[Severe]

[Very severe]

19. After how long did it last? […….]

20. Is there any care you sort for the effect?

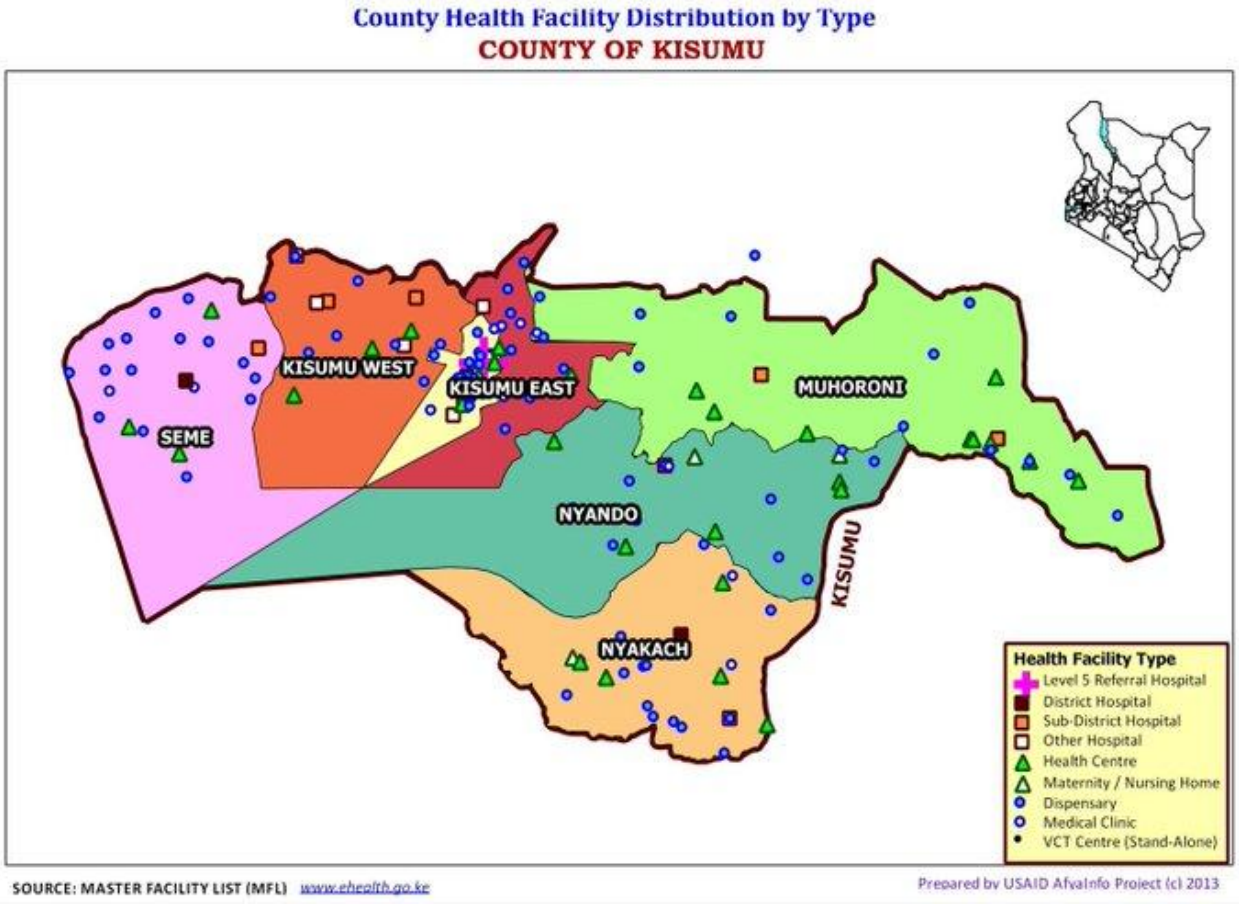
[Yes]

[No]

21. If yes, which one? […….]

22. Did the side effect change your attitude towards the vaccine? [Yes] [No] Explain your answer […….]

Appendix 3: Map of Kisumu County



Appendix 4: Map of Muhoroni Sub-County Wards