

**EFFECTIVENESS OF MALARIA CASE MANAGEMENT IN UNDER-FIVE
CHILDREN BY COMMUNITY HEALTH WORKERS IN THYOLO AND CHIKWAWA
DISTRICTS IN MALAWI
FROM 2017 TO 2021**

BY

MWAYI WINSTONE PENDAME

A dissertation submitted in partial fulfilment of the requirements for the degree of
Master of Science in Tropical Infectious Diseases and Zoonosis

THE UNIVERSITY OF ZAMBIA

LUSAKA

©2024

COPYRIGHT

No part of this research may be reproduced, stored in a retrieval form or system, or transmitted in any form by any other means, electronic, photocopying, mechanical, or recording, without the owner's prior consent.

©Mwayi Winstone Pendame

All rights reserved

(2024)

DECLARATION

I **MWAYI WINSTONE PENDAME**, hereby declare to the best of my knowledge that this thesis represents my original work and that it has not previously been submitted for a degree or other qualification at the University of Zambia or any other institution.

Name: **MWAYI WINSTONE PENDAME** Signature: Date:

CERTIFICATE OF APPROVAL

This MSc dissertation of **MWAYI WINSTONE PENDAME** has been approved as fulfilling the partial award of the MASTER OF SCIENCE DEGREE IN TROPICAL INFECTIOUS DISEASES AND ZOONOSIS by the University of Zambia.

PROF CHUMMY S. SIKASUNGE

.....	
Supervisor	SignatureDate

.....	
Examiner 1	SignatureDate

.....	
Examiner 2	SignatureDate

.....	
Examiner 3	SignatureDate

.....	
Chairperson	SignatureDate
(Board of Examiners)	

ABSTRACT

Malaria is one of the infectious diseases that causes a lot of deaths in under-five children in sub-Saharan African countries and continues to be a public health problem. Most of these deaths occur in under-five children residing in remote and hard-to-reach areas where access to healthcare is a challenge because of long distances to the health facilities. The use of community health workers (CHWs) was introduced to improve access to healthcare and to reduce the under-five children's deaths due to malaria. However, there is limited information in terms of the effectiveness of CHWs in malaria case management in Malawi. The main objective of this study was to investigate the effectiveness of CHWs in malaria case management in Thyolo and Chikwawa districts of Malawi. This was a retrospective descriptive study design where eight (8) health centres were randomly selected within the catchment area and clusters in each of the selected districts where the CHWs are based. Malaria mortality trends and malaria admission trends were analysed before and after the introduction of malaria community case management. Analysis was done using SPSS, STATA, and R Studio. Tests used were independent t-tests, multiple linear regression, and time trend analysis tests such as Moving Average and Mann-Kendall Trend tests. The results from the years 2017 to 2021 showed that 53% of under-five malaria cases were seen in village clinics in Thyolo district and 38.5% in Chikwawa from the year 2017 to 2021. Further, there was a significant decline in the trends of malaria death rates over time ($p = \text{value } 0.036$). Thyolo district had a decline in mortality from 72.8 per 100,000 in 2013 to 24.7 per 100,000 in 2021, whereas Chikwawa district saw a decline from 99.4 per 100,000 to 36.2 per 100,000. Additionally, a significant mean difference ($p = 0.035$) was found between the two districts, with Chikwawa district having more cases ($M = 9142$) than Thyolo district ($M = 2235$). Admission trends also statistically declined ($p = \text{value: } 0.034$) after the community case malaria programme from 2017 to 2021. Country-wide study will help to establish the effectiveness of CHW for the whole of Malawi. The study recommends a need to continuously support the CHWs, more sensitisation meetings to the communities to continuously access the health services rendered by the CHWs and to consider increasing the age group accessing services by CHWs.

DEDICATION

I dedicate this work to my wife Myrnah and children: Tadala, Owakhelha and Eben-Ezer. I thank you all for your patience and prayers during my absence from home for quite a long period. You have been very supportive regarding spiritual and mental health till the completion of this project. Above all thanks to the almighty God for the wisdom, knowledge, and good health during this entire period, may His name be praised now and forever more.

ACKNOWLEDGEMENTS

This project would not have been possible without the support of many people. Many thanks to my supervisor, Prof. Chummy Sikasunge, who read numerous revisions and provided constructive guidance. Also, thanks to my co-supervisors Prof. Martin Simuuza and Dr. Kondwani Chidziwisano who tirelessly offered guidance and support to me. Thanks to the University of Zambia for providing the necessary facilities for learning. Thanks to the African Centre of Excellence for Infectious Diseases of Humans and Animals (ACEIDHA) for awarding me financial support for this project with funding from the World Bank. Wish to acknowledge Dr Jumbe and Dr Nsopole in Thyolo and Chikwawa districts respectively for allowing me to do my research in their respective districts. I also recognise the support from Mr Marvin Phonera, Happy Chitani, Ziwanani Phiri, Emmanuel Francisco, Matola Dauda, and my classmates Mwiza Munang'andu and Masanja Lugelongi. To my parents Wyson and Charity and my brothers Nkamula, Ulemu, Tilimbe and my sister Mwinjiwawo thanks for the support and prayers. And finally, thanks to my wife, parents, children, and numerous friends who endured this long process with me, always offering support and love.

TABLE OF CONTENTS

COPYRIGHT	ii
DECLARATION	iii
CERTIFICATE OF APPROVAL.....	iii
ABSTRACT.....	iv
LIST OF FIGURES.....	ix
LIST OF TABLES	x
LIST OF ABBREVIATIONS	xi
CHAPTER ONE	1
1.0 INTRODUCTION	1
1.1 Background to the study.....	1
1.2 Problem Statement	2
1.3 Aim of the Study	3
1.4 Objectives.....	3
1.4.1 General Objectives	3
1.4.2 Specific Objectives.....	3
1.5 Research Questions	3
1.6 Significance of the Study	4
1.7 Scope of the Study.....	4
9.0 Operational Definitions	4
CHAPTER TWO	6
2.0 LITERATURE REVIEW	6
2.1 Aetiology of Malaria	6
2.2 Geographical Distribution of malaria.....	6
2.3 Lifecycle and Transmission of malaria	7
2.4 Diagnosis of malaria.....	9
2.5 Treatment of malaria	10
2.6 Complications of malaria	11
2.7 Prevention of malaria	11
2.8 Malaria Community Case Management.....	11
2.11 Community Health Workers in Malawi	14

CHAPTER THREE	17
3.0 MATERIALS AND METHODS.....	17
3.1 Study Site	17
3.2 Study Design.....	18
3.2.1 Inclusion Criteria	19
3.2.2 Exclusion Criteria	19
3.3 Sampling Techniques	19
3.4 Sample Size	20
3.5 Data Collection tools.....	21
3.6 Data Analysis	21
3.7 Ethical Considerations	22
CHAPTER FOUR.....	23
4.0 RESULTS	23
CHAPTER FIVE	32
5.0 DISCUSSION	32
CHAPTER SIX.....	36
6.0 CONCLUSION AND RECOMMENDATION	36
REFERENCES	38
APPENDICES	45
Appendix A: Village clinic Checklist	45
Appendix B: Health Centre Checklist.....	46
Appendix C: Hospital Checklist.....	47
Appendix D: Institution approval letter	48
Appendix E: Ethical Approval by Malawi National Health Research Committee	49
Appendix F: Permission to conduct research by Thyolo District Health Office	50
Appendix F: Permission to conduct research by Chikwawa District Health Office	51

LIST OF FIGURES

Figure 2.1: Distribution of malaria worldwide .	7
Figure 2.2 Lifecycle of Malaria	8
Figure 3.1: Study sites (Source: Generated from Arc GIS software).	18
Figure 4.1 Under-five Malaria Mortality Rate Trends for Thyolo and Chikwawa Districts from 2013 to 2021	26
Figure 4.2 A bar chart of Under 5 admitted Malaria Cases with the trends of admission rates in Thyolo and Chikwawa Districts from 2017 to 2021	30

LIST OF TABLES

Table 3.1: The population size for the clusters (health centres with village clinics) in Thyolo and Chikwawa districts.....	20
Table 3.2: Calculations for the sample size of stratum- Chikwawa and Thyolo Districts.....	21
Table 4.1: The proportion of under-five malaria cases managed by Community health workers and those managed at health centres in Thyolo and Chikwawa districts after the intervention from 2017 to 2021.	24
Table 4.2. Comparing Village clinic means of Under-five malaria confirmed cases using Independent Samples T Test.....	24
Table 4.3 Thyolo and Chikwawa districts Under-five malaria Mortality rate trends using Mann-Kandall Trend Test and Sen’s slope Time Series analysis from the year 2014 to 2021.....	27
Table 4.4 Thyolo and Chikwawa districts Under-five malaria Case Fatality rate per 100,000 trends using Mann-Kendall Trend Test and Sen’s slope Time Series analysis from the year 2013 to 2021.	28
Table 4.5: Effect of interventions (deaths and Survival rate) before and after intervention in Chikwawa Districts.....	28
Table 4.6: Under-five Malaria deaths before community health worker intervention and after intervention in Thyolo and Chikwawa Districts.	29
Table 4.7: Attributable Fraction of death before community health worker Intervention (2012-2016) and after intervention (2017-2021) in Thyolo and Chikwawa District.	29
Table 4.8 Thyolo and Chikwawa districts Under-five severe malaria admission rate per 100,000 trends using Mann-Kandall Trend Test and Sen’s slope Time Series analysis from the year 2014 to 2021.	31

LIST OF ABBREVIATIONS

CHWs	Community Health Workers
CK	Chikwawa
DHO	District Health Office
GoM	Government of Malawi
HSAs	Health Surveillance Assistants
iCCM	Integrated Community Case Management
MoH	Ministry of Health
mRDT	Malaria Rapid Diagnostic Testing
NHRSC	National Health Science Research Committee
NMCP	National Malaria Control Programme
PCR	Polymerase Chain Reaction
SDG	Sustainable Development Goals
TO	Thyolo
UN	United Nations
UNZA	University of Zambia
UNZABREC	University of Zambia Biomedical Research and Ethics Committee
VC	Village Clinic
WHO	World Health Organisation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Malaria remains one of the infectious diseases with major public health concerns in the tropics, with a higher morbidity and mortality rate, especially in under-five children and Malawi is no different. In the African continent, malaria accounts for a significant portion of the malaria burden, accounting for 95% of cases and 96% of deaths, with 80% of malaria deaths occurring in children under the age of five. Most of malaria deaths are from remote areas where access to healthcare is limited (WHO, 2022d). Malaria is prevalent in rural regions of Malawi at a rate of 40% by rapid diagnostic tests and 27.5% by microscopy compared to urban areas with a prevalence of 6% using malaria rapid diagnostic tests and 4% using malaria microscopy (NSO, 2019). It is important to confirm malaria as there are other diseases such as typhoid, trypanosomiasis, viral hepatitis, leptospirosis among others causing similar presentation (SMO, 2022). The southern region of Malawi where the research was conducted, had a prevalence of malaria among children of 36.4% (NMCP, 2017). This high burden of disease requires qualified healthcare providers to properly manage the cases. The World Health Organisation (WHO) recommended the use of CHWs in the management of malaria in under-five children to bridge the gap in access to healthcare where formal services are distant or limited (WHO, 2021d).

The CHWs are known by different names in different countries. In Malawi, they are called health surveillance assistants (HSAs). Besides the malaria control programme, these HSAs are trained to manage other programmes such as Tuberculosis, HIV/AIDS, vaccines, diarrhoea, and pneumonia among others. However, this study looked at the effectiveness of the community case management of malaria by community health workers on malaria health outcomes through malaria programme indicators specifically in the communities where access to health care is a challenge because of distance to the health centres. The HSAs are provided with basic training to manage uncomplicated malaria and give a pre-referral treatment to severe malaria patients in the community to avoid developing complications that may lead to death because of the delay and poor access to formal health facilities. To become a Community Health Worker, an individual must possess a junior

certificate of education, which is the same as a grade 10 education. The HSAs reside in the communities for easy interaction with people and there is provision of a minimum incentive including uniforms, bicycles, bags, and stationery to enhance satisfaction (Kaunda-Khangamwa et al., 2019). In the study districts, 521 HSAs were assigned to work in Thyolo district while 335 HSAs were assigned to work in Chikwawa district. Despite the initiation of community case management of malaria programmes, there is a need to find out how the use of community health workers has contributed to the control of malaria in under five children through various health outcomes.

1.2 Problem Statement

Malaria remains a major public health problem in Malawi with an estimated 4 million cases occurring each year and with a prevalence of 24% as of 2018. Malawi has also been reported as the fourth highest in terms of high malaria mortality in Sub-Saharan Africa. Most of these cases are under the age of five with a death rate of 20% (WHO Report, 2018). The malaria indicator survey conducted in 2017 showed that there was a higher prevalence in children from poor households representing 48% and a higher prevalence of 41.9% in rural areas with only 7.3% in urban areas (NMCP, 2017).

The prevalence of malaria in the year 2018 in under five children was distributed as follows: 25 % in 6-23 months, 40.6% in 24-41 months and 43.4 % in 42-59 months (NMCP, 2017). The community case management of malaria by community health workers has proven to be significant in reducing the morbidity and mortality rate for under-five children in countries such as Uganda, and Zambia among others (Bagenda et al., 2022). However, there is no substantive research findings on the contribution the community health workers have to malaria community case management outcomes in the Thyolo and Chikwawa districts of Malawi.

1.3 Aim of the Study

This study aimed to assess the effectiveness of community case management of malaria on health outcomes by Community Health Workers in the Thyolo and Chikwawa districts of Malawi.

1.4 Objectives

1.4.1 General Objectives

To assess the effectiveness of community case management of malaria by Community Health Workers in Thyolo and Chikwawa districts of Malawi.

1.4.2 Specific Objectives

- i. To determine the proportion of under-five malaria cases managed by the community health workers and those managed at the health centres in Thyolo and Chikwawa districts from 2017 to 2021.
- ii. To compare the under-five malaria mortality rate trends before and after community case management in Thyolo and Chikwawa districts from 2013 to 2021
- iii. To compare the under-five malaria admission trends between Thyolo and Chikwawa districts after the introduction of community malaria case management from 2017 to 2021

1.5 Research Questions

In line with the above general and specific objectives, the precise research questions for this study were as follows:

- 1.5.1** What was the proportion difference in under-five malaria cases being managed by community health workers to cases being managed at the health centres and district hospitals from 2017 to 2021?
- 1.5.2** What was the trend of the under-five mortality rate in Chikwawa and Thyolo after the introduction of community malaria case management?
- 1.5.3** What is the trend of malaria in under-five children's admissions after the introduction of community malaria case management by community health workers from 2017 to 2021?

1.6 Significance of the Study

The use of community case management of malaria by CHWs in the health care system has proven to address health inequalities in other countries, like Uganda, where there is a significant improvement in the management of malaria, pneumonia and diarrhoea causing an increase in morbidity and mortality rate in under-five children (Bagenda et al., 2022). This strategy has been introduced because of the critical shortage of qualified health professionals to manage healthcare problems and an increase in the mortality rate for under-five children. It is reported that 84 per cent of Malawians live in rural areas where most deaths occur and where access to health care is a challenge (Chipukuma et al., 2020). For instance, the doctor-to-patient ratio remains high at 1:50.000 from the recommended 1:1000 by WHO (Bickton & Lillie, 2019). This study also provided information on how useful the HSAs in Malawi, specifically, in the study districts in reducing malaria morbidity and mortality rates in under-five children and improving access to care-seeking healthcare-seeking behaviour. The study may also be an index to do further research to explore challenges faced during the implementation of this program so that there is a provision of quality care to the communities in malaria case management in under-five children and reduce health inequalities.

1.7 Scope of the Study

This study assessed the effectiveness of community case management of malaria by CHW in malaria control in Thyolo and Chikwawa districts of Malawi.

9.0 Operational Definitions

Clinical malaria case: Occurrence of malaria infection in a person in whom the presence of malaria parasites in the blood has been confirmed by a diagnostic test (WHO, 2021b)

Malaria Mortality: This is an estimated number of malaria deaths per 100,000 population at risk (WHO, 2022b)

Community Health Worker: These are health care providers who live in the community they serve with a junior certificate of education, which is the same as a grade 10 education and receive lower levels of formal education and training than professional health care workers such as nurses and doctors to serve as a bridge between communities, health care systems, and state health departments (WHO, 2021c)

Village Clinic: This is the health facility in the community run by Community Health workers managing primary health care services to ensure there is easy access to health care and serve as a bridge between communities and health centres where there are qualified nurses and clinicians (UNICEF, 2021).

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Aetiology of Malaria

Malaria is a parasitic and life-threatening infection caused by a protozoan of the genus *Plasmodium*. It is characterised by a high morbidity and mortality rate in Africa especially in under-five children because they have lost maternal immunity and they have not yet developed specific immunity to infection. As a result, they can easily develop severe malaria complications which cause deaths. Therefore this becomes even worse if there is a delay in the treatment especially in those people with poor access to health care in the communities that are hard to reach (Schumacher & Spinelli, 2012).

2.2 Geographical Distribution of malaria

Transmission of malaria occurs throughout the year in most parts of Africa, unlike other continents where transmission occurs in selected areas and not throughout the year (**Figure 2.1**). In 2019, there were 229 million malaria cases globally which led to a total of 558,000 deaths. Out of these deaths, 74% (416,000) were children under 5 years of age and approximately 95% of these malaria cases are in Africa with a 96% death rate. Of these deaths, 80 per cent occurred in under five children (UNICEF, 2022). In the year 2020, 240 million cases of malaria and 627,000 malaria deaths have were reported globally (WHO, 2021d). WHO set strategies to control and eliminate malaria through the reduction of malaria case incidence by at least 90% by 2030, reducing the malaria mortality rate by at least 90% by 2030, elimination of malaria in at least 35 countries by 2030 and preventing a resurgence of malaria in all malaria-free countries(WHO, 2021a).

Malawi is among the top 15 countries with a high malaria burden accounting for 2% of malaria cases worldwide (WHO Report, 2018). In Malawi, the risk for malaria morbidity is higher in under 5 years children and pregnant women compared to other groups (Chilanga et al., 2020). The prevalence of malaria in Malawi as of 2018 stood at 24% with 6.2 million cases that are diagnosed every year. Out of these malaria cases, under-five children cover 40 percent of hospital admissions and four out of 10 hospital deaths are due to malaria. The disease is endemic in 95% of the country with 98% of infections due to the parasite *Plasmodium falciparum*, which causes severe forms of malaria apart from other malaria parasite such as *Plasmodium vivax*, *Plasmodium ovale*, *P. malariae* and *Plasmodium knowlesi* (Paniker, 2018). Most malaria cases are from remote areas

where access to health care is a challenge because of the long distances to the health facilities and there are inadequately qualified health professionals (Gaston & Ramroop, 2020). The inadequacy of qualified health personnel led to the development of a task-shifting strategy in which the community health workers were used to manage malaria cases which is helping to minimise deaths and improve access to health care services.

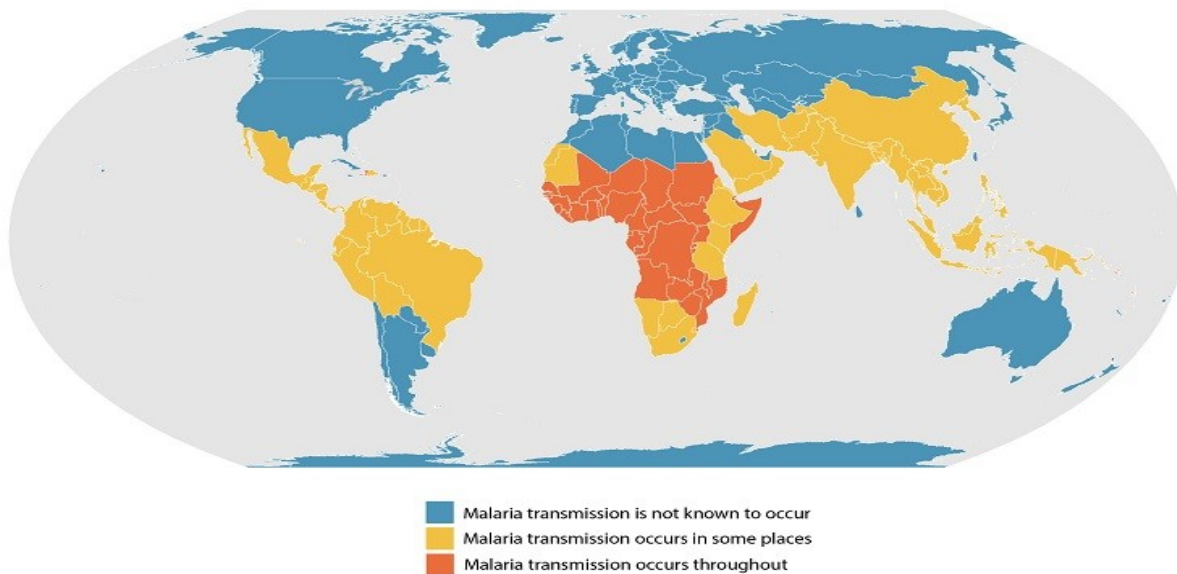


Figure 2.1: Distribution of malaria worldwide (Source: <https://www.cdc.gov/malaria/about/distribution.html> (CDC, 2021)).

Figure 2.1 shows how malaria is distributed worldwide. In African continent malaria transmission occurs throughout the year, unlike other continent where malaria occurs in selected places with limited transmission.

2.3 Lifecycle and Transmission of malaria

The malaria parasite life cycle involves two hosts (**Figure 2.2**). Its definitive host is the female *Anopheles* mosquito. Modes of transmission are via bite of infected *Anopheles* mosquito, blood transfusion, congenital transmission and shared syringes. During a blood meal, a malaria-infected female *Anopheles* mosquito inoculates sporozoites into the human host (1). Sporozoites infect parenchymal cells (hepatocytes) within 30 minutes (2) and mature and replicate into hepatic schizonts (3), until several thousand merozoites (4) are produced and released in the bloodstream. However in *P. vivax*, but not in *P. falciparum*, some liver parasites remain instead quiescent (hypnozoites) resuming replication, and infection after several weeks or months or even years later

(Flannery et al., 2022). After this initial replication in the liver (Exo-erythrocytic schizogony- A), the parasites undergo asexual replication in the erythrocytes (Erythrocytic schizogony- B) forming mature schizonts whose rupture releases merozoites that invade new erythrocytes (5). The ring stage trophozoites mature into schizonts, which rupture releasing merozoites (6). Some blood stage parasites differentiate instead into male and female gametocytes (7) that, when ingested in the mosquito blood meal, are activated to produce gametes. Blood stage parasites are responsible for the clinical manifestations of the disease.

The gametocytes, male (microgametocytes) and female (macrogametocytes), are ingested by an *Anopheles* mosquito during a blood meal, the asexual forms of malaria parasite are digested. The gametocytes undergo further development in the midgut (stomach) of mosquito. (8). The parasites 'replication in the mosquito is known as the sporogonic cycle which is also the sexual phase in the definitive host (C). While in the mosquito's stomach, the microgametes penetrate the macrogametes generating zygotes (9). The zygotes in turn become motile and elongated (ookinetes) (10) which invade the midgut wall of the mosquito where they develop into oocysts (11). The oocysts grow, rupture, and release sporozoites (12), which make their way to the mosquito's salivary glands. Inoculation of the sporozoites (1) into a new human host perpetuates the malaria life cycle. The time taken for completion of sporogony in the mosquito is about 1–4 weeks, depending on the species and environmental temperature.(Mahmud et al., 2017).

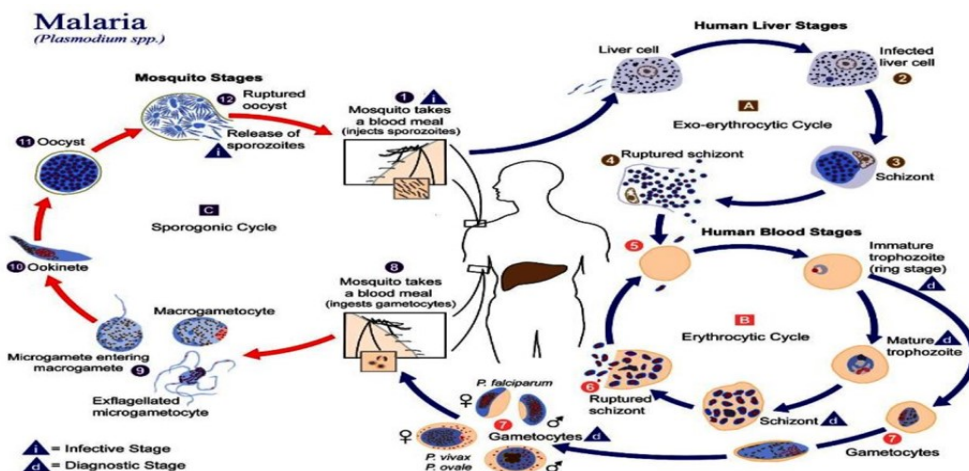


Figure 2.2 Life cycle of malaria (Source: CDC, 2024).

Figure 2.2 shows stages involved in malaria life cycle such as mosquito stage, human liver stage and human blood stage

2.4 Diagnosis of malaria

Several methods are used to diagnose malaria, and these are clinical, parasitological, serological and molecular tests. Clinical method involved using signs and symptoms, parasitological tests involves use of microscopic examination of blood films as a gold standard test, serological test involves use of rapid diagnostic test which is an alternative way of quickly to diagnose malaria and polymerase chain reaction (PCR) to detect Parasite nucleic acids which is limited in the diagnosis of acutely ill patients in the standard healthcare setting (CDC, 2024). An example of PCR test which is sensitive, feasible and affordable in poor income settings is modified semi-nested multiplex malaria PCR (SnM-PCR). Other tools are also used to identify different mosquito species and these include the use of proteomics tools, isozyme analysis and nucleic acids sequencing (Jourdain et al., 2018). In a study done in Equatorial Guinea comparison of three diagnostic methods (microscopy, RDT, and PCR) for the detection of malaria parasites, a total of 1724 samples tested by microscopy, RDT, and SnM-PCR were analysed. Among the negative samples detected by microscopy, 335 (19.4%) were false negatives. In contrast, the negative samples detected by RDT, 128 (13.3%) were false negatives based on PCR (Berzosa et al., 2018). Further to that, a 26 meta-analysis study was carried out in the year 2020, which showed that rapid diagnostic test had good accuracy in diagnosing malaria in children under 5 years of age. And the diagnostic performance of parasite-specific lactate dehydrogenase test was better than that of the histidine-rich protein 2 tests (Hu et al., 2021). In terms of clinical presentation, signs and symptoms of malaria are non-specific. Most of the time malaria is suspected clinically, primarily based on fever or a history of fever. No combination of signs or symptoms reliably makes a distinction between malaria and other causes of fever. This is because other diseases such as bacterial infections, viral infections, fungal infections among others can also cause the same malaria signs and symptoms (Baltzell et al., 2019). Therefore, the diagnosis based on signs and symptoms is not reliable because it results in overtreatment of uncomplicated and severe malaria cases. This is following the study done in Kenya which was looking at frequency and correlates of malaria overtreatment in areas of differing malaria transmission. The results of the study showed that there was overtreatment of cases which resulted in an increase in malaria prevalence that does not give the actual reflection. In addition, overtreatment of cases may fail to treat other serious causes of fever increasing mortality rate, drug resistance, and unnecessary treatment costs (Onchiri et al., 2015). Malaria is classified as uncomplicated and severe malaria. Clinical features of

uncomplicated malaria include fever, malaise, headache, myalgias, and at times nausea, vomiting and diarrhoea. Severe symptoms of malaria are impaired consciousness, multiple convulsions, respiratory distress, jaundice, acute kidney injury, anaemia etc. The diagnosis of malaria is confirmed by performing the parasitological tests such as malaria rapid diagnostic test (mRDT) for uncomplicated malaria and malaria microscopy for severe malaria (WHO, 2022c).

2.5 Treatment of malaria

National Malaria Control Programme (NMCP) in connection with WHO recommends treatment of malaria upon confirmation through parasitological tests such as mRDT except for severe malaria manifestation where there is a provision to start treatment immediately because of an increase in mortality rate. While on treatment parasitological tests and other tests are also done for proper monitoring of the patients. In the case of uncomplicated malaria, artemisinin-based drugs such as oral Lumefantrine Artemether (LA) is given. In the case of severe malaria parenteral Artesunate is a definitive treatment given at the hospital, while intramuscular Artesunate is given at health centres and by qualified nurses and clinicians rectal Artesunate is given as pre-referral treatment for suspected severe malaria under five patients by CHWs. This means that all severe malaria are supposed to be thoroughly managed at the district hospital where further laboratory investigations and monitoring is done (GoM, 2020).

Despite multiple interventions, Challenges remain in terms of anti-malarial drug resistance, which threatens malaria treatment and control of malaria. In Africa, anti-malaria medication resistance patterns are still evolving, including resistance to aminoquinolines, ant-folates, and chloroquine. Studies have also demonstrated that there is a rise of resistance to common medications in Africa called artemisinin-based combination therapy in Southeast Asian countries. (Ippolito et al., 2021). Currently, resistance to artemisinin or main partner drugs included in combination therapies does not seem to be a significant problem in Africa. Nevertheless, the emergence of resistance to artemisinin-based combination therapies in Africa would probably have devastating consequences. Therefore there is a need to highly prioritise continued surveillance for the emergence of resistance on this continent (Conrad & Rosenthal, 2019).

2.6 Complications of malaria

Malaria results in the development of complications of which some are short term while others are long term. Most of these complications increase the mortality rate occurring in both under-five children as well as over-five children. Some of the complications of malaria are acute kidney injury, respiratory distress, abnormal bleeding, anaemia, hypoglycaemia acidosis, cerebral malaria, development of epilepsy and neurocognitive impairment in children (Conroy et al., 2019). Most complications of malaria develop because of delay in treatment as it is the same with under five children residing in hard-to-reach areas where there are long distances to access urgent care in the health centres.

2.7 Prevention of malaria

It has been proven that the use of long-lasting insecticide-treated nets and indoor residual spraying has resulted in a decline in the incidence and prevalence of malaria in Sub-Saharan Africa (Loha et al., 2019). It has also been established that some strategies, such managing the larval source management, can lower mosquito densities; however, these techniques still need further research. There are new methods under development such as house improvement which have been shown to minimise disease burden but need further evidence on efficacy. Development of the RTS, S/AS01 malaria vaccine that protects under-five children has led to further progress in efforts to control malaria (Tizifa et al., 2018). WHO and Malawi are rolling out this new malaria vaccine for young children to reduce malaria deaths. In Africa, the malaria vaccine was pilot-tested on more than one million children in selected countries such as Ghana, Kenya and Malawi. This vaccine was recommended in the year 2021 by the WHO despite having a low effectiveness rate of 30%. The vaccine has raised expectations that more than 400,000 children who die every year from malaria can be saved (Van Den Berg et al., 2019).

2.8 Malaria Community Case Management

According to WHO, there is a global health workforce shortage of more than four million, and it is worse in many of the countries of sub-Saharan Africa, and in parts of Asia and the Americas (WHO, 2022a). United Nations (UN) developed a principle of leaving no one behind as a central, transformative promise of the 2030 agenda to its Member States. This represents the unequivocal commitment of all UN Member States to reduce the inequalities and vulnerabilities that leave people behind and undermine the potential of individuals and humanity. The primary health care

approach has helped to control the disease by ensuring that health services are accessible to everyone in a principle of health for all (UNSDG, 2022).

In the year 2018, WHO recommended community health workers to manage some common conditions in areas that are hard to reach (Turap et al., 2018). This process of task shifting is a process of delegation whereby tasks are moved from highly specialised to less specialised health workers, in this case, community health workers. Malawi faces a critical shortage of doctors with a doctor to patient ratio of 1:50,000 people as opposed to the prescribed ratio of 1:1000 by the World Health Organisation. At the same time, the demand for health care is rising because of an increase in population. The world is now facing a chronic shortage of trained health workers (Bickton & Lillie, 2019).

2.9 Barriers to access malaria treatment in malaria Community Case Management

Distance to healthcare sites in rural areas of Africa has long been linked with greater morbidity and mortality among under-five children with malaria (O'Meara et al., 2009). Those residing away from healthcare centres have a greater risk of progressing from uncomplicated to severe malaria (Al-Taïar et al., 2008). A study performed by the Southern and Central Africa International Centres of Excellence for Malaria Research (ICEMR) team in Nchelenge District, Luapula Province, Zambia showed higher mortality in children with severe malaria from villages located further from the hospital. Each additional kilometre from the hospital was associated with a 4% increase in odds of death, with a median distance to the hospital of 14 km in children who died from severe malaria compared to 3 km in those who survived (Ippolito et al., 2018). To alleviate this health burden faced by individuals living in remote villages, many nations have started integrated community case management (iCCM) programmes as an attempt to bring evidence-based healthcare services into previously unserviceable areas.

A study conducted in Malawi by Mhango et al. (2023) also revealed other characteristics that function as obstacles to receiving treatment for malaria. The study looked at barriers to malaria treatment in the health-care system, such as long wait times and lines at clinics, frequent shortages of medical supplies, and travel time to the facility. The provider's challenges were limited-service hours and a dismal outlook. Cultural and personal barriers included the belief that witchcraft is the most efficient way to treat malaria, as well as the fear of testing positive for the disease. Other COVID-19-related barriers were an inability to adhere to preventive measures, a shift in attention

from malaria to COVID-19, and concern about contracting COVID-19 or being tested for it at the health facility. (Mhango et al., 2023).

2.10 Definition and the Role of the Community Health Worker

Community health workers are defined as non-professional, lay health workers who work in the communities where they reside, and who are equipped with training and incentives to provide promotional, preventive and basic curative healthcare services to community members (Pallas et al., 2013) . WHO defines community health workers (CHWs) as healthcare providers who live in the community they serve and receive lower levels of formal education and training than professional healthcare workers such as nurses and doctors. These CHWs play an important role in primary health care by having huge potential to extend health care services to vulnerable populations, such as communities living in remote areas and historically marginalised people, to meet unmet health needs in a culturally appropriate manner, improve access to services, address inequities in health status and improve health system performance and efficiency (WHO, 2021c). Further to that WHO introduced iCCM to improve the integration and quality of health care services at community and health facility levels to enhance case management, early detection of risk factors associated with severe outcomes, and improve childhood survival. It has even been proven in Kenya that using CHWs in diagnosing malaria under the iCCM strategy yielded good results which are similar when done by qualified health personnel such as nurses, clinicians, and laboratory technicians. This includes doing mRDT and identifying signs and symptoms of malaria (Marita et al., 2022).

A study done in Zambia reviewed that community case management was effective in severe malaria and inpatient deaths. The study captured 310,855 malaria admissions and 7,158 inpatient malaria deaths over 83 districts in seven provinces from January 2015 to May 2020. Total CHWs increased from 43 to 4503 during the study period, while health facilities increased from 1263 to 1765. After accounting for covariates, an increase of one malaria service point per 1000 was associated with a 19% reduction in severe malaria admissions among children under five (incidence rate ratio [IRR] 0.81, 95% confidence interval [CI] 0.75–0.87, $p < 0.001$) and 23% reduction in malaria deaths among under-fives (IRR 0.77, 95% CI 0.66–0.91) (Ashton et al., 2023).

Despite good results from CHWs in the management of under-five malaria cases in the community, some challenges still exist. These are high patient load, limited knowledge and supervision, lack

of compensation, inadequate drugs and supplies, unrealistic expectations of community members and at times they are given tasks that are beyond what they are trained to do. However, the CHWs still feel motivated to volunteer for humane reasons. They feel the main benefits of their work appear associated with becoming someone important with the potential for social mobility for self and family, as well as building relationships with health workers. At the same time, more than half of CHWs felt demotivated due to inadequate support from communities and the health system (Banek et al., 2015). It has also shown that despite gaps in the community malaria case management, ongoing mentorship, training and proper supervision should be explored to improve the quality of care, and programming which moves away from vertical financing with short-term support, to a more holistic approach with embedded sustainability may address a proper balance of resources for different conditions (Kilov et al., 2021).

2.11 Community Health Workers in Malawi

For one to qualify for a Community Health Worker, is supposed to have a minimum education level of junior certificate which is equivalent to grade 10. They are required to go for a 10-week basic training on the core set of tasks they are responsible for. The community health workers in Malawi are trained on how to manage malaria cases especially in under five children by doing malaria rapid diagnostic testing and giving treatment for uncomplicated malaria as well as pre-referral anti-malaria treatment for severe malaria cases (Nsona et al., 2012).

In the year 2008, Malawi introduced integrated community case management (iCCM) of childhood illness to make sure that under-five children have access to early diagnosis and treatment of malaria and other childhood illnesses. During this time, in the year 2008, malaria cases were treated using symptomatic approach without any confirmatory test (Global fund, 2020). In the year 2016 the CHWs were trained how to handle malaria case management in under five children as well as conducting a confirmatory test using rapid diagnostic test. As such, CHWs are required to diagnose malaria through signs and symptoms and perform malaria rapid tests to confirm the diagnosis. Once malaria diagnosis is confirmed, treatment is offered and CHWs make a proper follow-up. Severe malaria cases are given rectal Artesunate as a pre-referral treatment to the health centre which will further refer the under-five child to the district hospital for further management. The CHWs were trained on how to perform malaria rapid diagnostic testing and malaria case

management in the year 2016 so that they anti-malarial treatment are only given to the confirmed malaria cases (Phiri et al., 2016).

These CHWs who are known as Health Surveillance Assistants (HSAs) in Malawi are given monthly salaries to provide services such as disease prevention, health promotion, and basic curative health services in their communities. The key responsibilities of HSAs are to conduct health education and awareness campaigns on various health issues, including nutrition, hygiene, and family planning, identifying and reporting outbreaks of communicable diseases, providing basic treatment for common illnesses such as malaria, diarrhoea, and respiratory infections, distributing medicines and other health commodities and conducting home visits to promote health and provide care to vulnerable populations such as pregnant women, new-borns, and people living with HIV.

The HSA program in Malawi has proven a success in improving access to health care in rural and remote areas where there is a shortage of qualified health personnel and a lot of deaths from malaria under-five children (Nsona et al., 2012). Therefore, the Ministry of Health (MoH) through the Government of Malawi (GoM) decided that the implementation strategy would target HSAs in hard-to-reach areas based on the distance to the nearest health facility of 8km or more or difficult access due to geographical terrain or natural barriers. Using these criteria, 3452 were identified as hard-to-reach areas. This has led to a reduction in maternal and child mortality rates. The program has also been credited because of its contribution to the reduction of malaria and HIV/AIDS prevalence rates in the country. Malawi is also one of the countries in Sub-Saharan Africa to scale up the iCCM for common child illnesses. An assessment has also shown that HSAs can treat sick children similar to services offered at health centres where there are qualified nurses and clinicians (Nsona et al., 2012). As part of stipend HSAs receive an approximately US\$150 per month but there is not a retention policy specific for these CHWs. In Malawi, Ministry of Health (MoH) recommends a health centre radius of five kilometres. The integrated community case management (iCCM) programme is therefore intended to serve communities more than five kilometres from a health facility. In addition to these core duties, CHWs also provide iCCM services including testing, treatment, and referral of severe malaria cases to the health centre. There are variety of activities performed by CHWs at the community level such as (iCCM) and malaria case management, for children under five years of age at the community level. The target for the GoM

was to reach a ratio of 1 HSA per 1,000 population by 2022. As of 2021, the ratio was 1 HSA per 2,095 population (SMO, 2022)

The use of CHWs has been proven a success in other countries such as Honduras where there is community malaria case management. Their use in malaria management has resulted in a significant decline in mortality and morbidity rates (Napier et al., 2021). It has also been proven in Kenya that engaging CHWs to diagnose malaria cases under the community malaria case management strategy produced results which compared well with the results of qualified experienced laboratory personnel. Therefore CHWs reliably continue to offer malaria diagnosis using malaria rapid diagnostic testing (mRDTs) in the community setting (Marita et al., 2022).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Site

This study was conducted in Thyolo which has a low malaria prevalence (10%) and Chikwawa district which had a high prevalence of malaria (15%). Thyolo and Chikwawa districts are in the southern region of Malawi as shown in figure 3.1.

The study sites covered village clinics, health Centres and Hospitals from Thyolo district and Chikwawa districts (**Figure 3.1**). Thyolo district is located approximately 34km from the city of Blantyre. The area terrain is slopy surrounded by mountains. In terms of the climate, the hottest month of the year in Thyolo is November, with an average high of 85°F and low of 69°F. The cool season lasts for 2.2 months, from June 1 to August 8, with an average daily high temperature below 75°F. The coldest month of the year in Thyolo is July, with an average low of 58°F and high of 73°F. The district covers an area of 1,715 km² with a population of 721,456 and is located 743 metres above sea level. Chikwawa district covers an area of 4,755 km² and is located 50km from Blantyre city with a population of 566,283. It is located at an elevation of 112 metres above sea level along the lower flat basin of Shire River which is along the Great East African Rift Valley. Its main topographic features are undulating terrain surface, but is predominantly flat. In terms of climate, the hottest month of the year in Chikwawa is November, with an average high of 95°F and low of 79°F. The cool season lasts for 2.3 months, from May 31 to August 8, with an average daily high temperature below 85°F (NSO, 2019).

Thyolo district has a total of twenty-five (25) health facilities (23 health centres and three hospitals). Chikwawa district has a total of twenty-two (22) health facilities (18 health centres and three hospitals). There are village clinics under each health centre which are run by HSAs.

Under five malaria data was collected randomly from a total of eight (8) Health Centres in each study district, three (3) hospitals from each study district and village clinics from eight (8) health centre catchment areas. There was a total of ninety-nine (99) village clinics in Thyolo district and eighty-eight (88) village clinics in Chikwawa district.

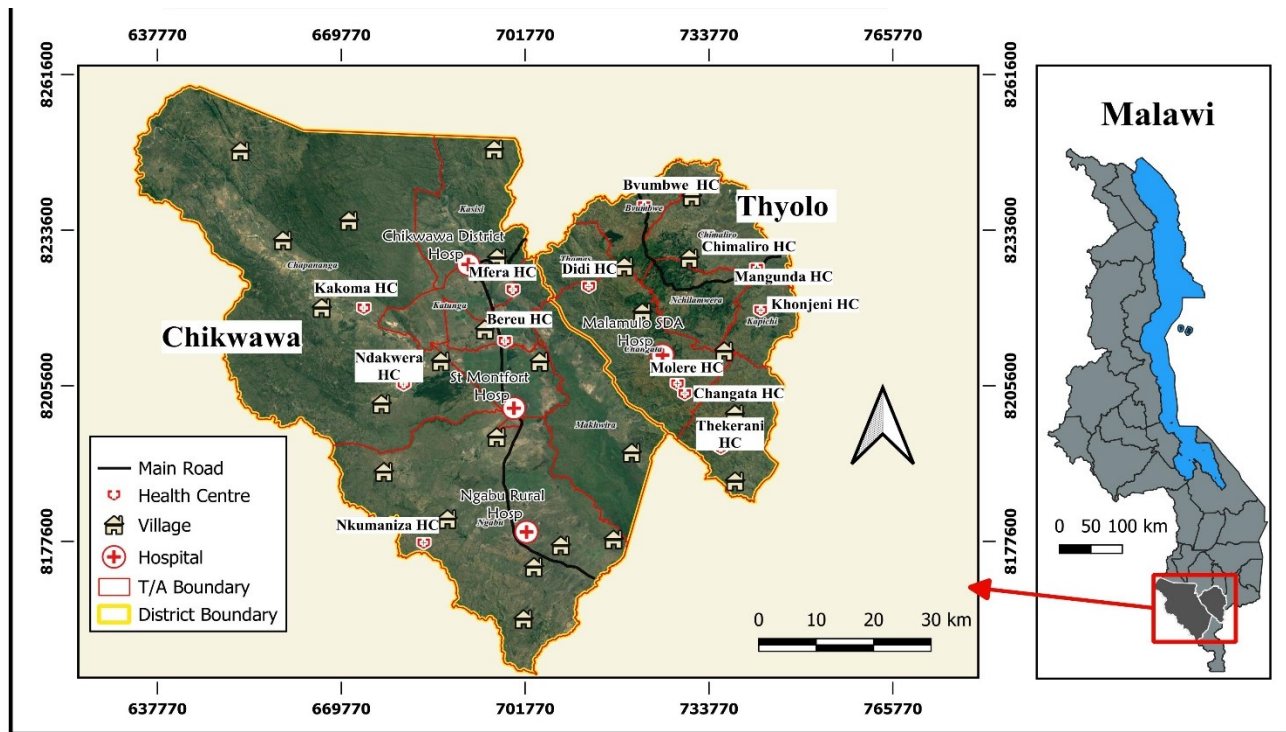


Figure 3.1: Study Sites Map for Chikwawa and Thyolo districts (Source: Generated from Arc GIS software).

Figure 3.1 shows the study district with health facilities in Thyolo and Chikwawa districts of Malawi.

3.2 Study Design

This study utilised a retrospective descriptive study design. This enables the researcher to examine and characterise the distribution of one or more variables without considering any causal or other hypotheses (Aggarwal & Ranganathan, 2019). The secondary data for the past 5 years after community under-five malaria case management intervention covering the years 2017, 2018, 2019, 2020 and 2021 and years before intervention (2013,2014,2015,2016) were collected from the HSAs reports, health centre reports, hospital malaria reports and district health information system (DHIS2) where all malaria data were captured. Data collection was conducted from August to November 2023.

Data collected from the village clinic involved under five malaria confirmed cases through rapid diagnostic testing, all under five malaria suspects as well as under five severe malaria referrals. The HSAs are only allowed to manage uncomplicated malaria under-five cases and refer severe malaria cases to the health centre upon giving pre-referral anti-malarial treatment. Then the health

centre refers the patient to district hospital which is secondary health facility. The health centre data involved the confirmed under five malaria cases. The Hospital data involved the admitted under-five malaria cases and the number of under-five malaria deaths.

3.2.1 Inclusion Criteria

The health centres in the districts with high malaria prevalence of 10% and above were included in the study. The health facilities with high reporting rates of more than 95% from CHWs from both selected districts Thyolo and Chikwawa were also included in the study to make sure data is adequate and consistent.

3.2.2 Exclusion Criteria

The health centres with low malaria prevalence of less than 10% in the districts were not included in the study. The health facilities with low reporting rates of less than 95% from CHWs were not included in the study.

3.3 Sampling Techniques

Thyolo and Chikwawa district's health centres that had village clinics were randomly selected. A minimum of 30 per cent of the representative population rule was used to calculate the size of the entire sample (Turney, 2022). Thereafter proportional sampling method was used to find the sample size of the stratum which has been represented as regions of the districts. Then simple random sampling was used to sample from within each stratum. This helped in generalizability and validity and avoided under-coverage bias.

The representative health centres with village clinics were selected randomly based on the region representing strata such as the southern, northern, eastern, and western regions of the Thyolo and Chikwawa districts. A total of eight (8) health centres with village clinics were randomly selected in Chikwawa and eight (8) health centres from Thyolo districts. A representative sample using proportionate sampling was used to select the number of health centres with village clinics in each stratum and then simple random sampling was used to select the health facilities with village clinics in each stratum which has been represented as regions. Each health facility with village clinics had an equal chance of being selected using the random number method.

Table 3.1: The population size for the clusters (health centres with village clinics) in Thyolo and Chikwawa districts.

No	Stratum	Thyolo district	Chikwawa district
1	South	9	5
2	North	6	8
3	West	6	7
4	East	4	3
	Total	25	23

3.4 Sample Size

The following proportionate sampling size equation was used to calculate the sample size of the stratum in the study areas.

$$n_h = (N_h / N \times n)$$

Where;

n_h = sample size of the h^{th} stratum

N_h = population size for h^{th} stratum

N = size of the entire population, n = size of the entire sample

Table 3.2: Calculations for the sample size of stratum- Chikwawa and Thyolo Districts.

NO	Stratum	Thyolo district (N _h)	Chikwawa district (N _h)	Thyolo district $n_h = (N_h/N \times n)$	Chikwawa district $n_h = (N_h/N \times n)$	Sample size of stratum-Thyolo (n _h)	Sample size of stratum-Chikwawa district (n _h)
1	South	9	5	$9/25 \times 8 = 2.88$	$5/23 \times 8 = 1.74$	3	2
2	North	6	8	$6/25 \times 8 = 1.92$	$8/23 \times 8 = 2.78$	2	3
3	West	6	7	$6/25 \times 8 = 1.92$	$7/23 \times 8 = 2.43$	2	2
4	East	4	3	$4/25 \times 8 = 1.28$	$3/23 \times 8 = 1.04$	1	1
	Total (N)	25	23			8	8

Table 3.2 shows the sampling ratio calculations for the study districts. Under the Thyolo district health office, the following health centres with village clinics were randomly selected: Thekerani, Changata, and Molere health centres represented Thyolo South; Chimaliro and Mangunda health centres represented Thyolo North; Khonjeni health centres represented Thyolo East; Bvumbwe and Didi Health centres represented Thyolo west. For the Chikwawa district, the following health centres with village clinics were randomly selected: Mkumaniza and Kakoma health centres represented Chikwawa South; Ndakwera and Bereu health and Nchalo hunger health centres represented Chikwawa North; Kapichira and Chinthumba health centres represented Chikwawa west; Mfera health centre represented Chikwawa east.

3.5 Data Collection tools

Checklists were used to collect secondary data from village clinics, health centres, hospital malaria reports and District Health information System (DHIS). The checklists focused on descriptive data on number of under five malaria cases suspected and confirmed using Malaria rapid diagnostic tests, and microscopy, total number of referrals from the village clinics, total under five malaria admissions, total under malaria deaths.

3.6 Data Analysis

The collected secondary data for this study was coded in Excel and the coded data were transferred to Statistical Package for Social Sciences (IBM SPSS) version 26, STATA, and R studio which was used to analyse the data such as malaria cases and deaths in the study period. Independent T-

test was used to compare the mean cases in two districts for the period from 2017 to 2021. The time trend analysis method was used to compare the trends of malaria from the time HSAs started doing confirmatory tests for malaria using rapid diagnostic tests and treatment of malaria under five cases from 2017 to 2021. Using R and R studio, analysing time trend analysis, the Mann-Kendall Trend test was used to determine trends whether declining or increasing, as well as determining whether the trend was statistically significant or not using a significance level of 0.05. Multiple linear regression analysis in SPSS was used to determine whether malaria under-five community case management intervention is significant in bringing an effect on the number of under-five malaria deaths as well as under-five malaria admissions. In addition, a simple two-year moving average in Excel as a time series method was also used to capture the average in data series over time and forecast the trend of under-five malaria mortality rate and under-five severe malaria admissions in the two districts based on the period of 2016 to 2021. The alpha value was set at 0.05. Microsoft Excel 2019 was used as a tool for data visualisation and organisation. As such Graphical representations of trends and patterns were conducted in Excel to compare trends over the years for a direct comparison of distribution between two study districts. Thereafter statistical conclusions were drawn to pave the way for practical conclusions to answer the research questions.

3.7 Ethical Considerations

The ethical clearance for this study was obtained from the Malawi National Health Science Research Committee (NHSRC) (Protocol #: 23/03/400). Permission to collect data from the districts was sought from Thyolo and Chikwawa District health offices. The supporting documents are attached in Appendices (A, B, C, C, D, E and F).

CHAPTER FOUR

4.0 RESULTS

4.1 Demographic Under five malaria data from selected health facilities for Thyolo and Chikwawa Districts

Description	Thyolo District	Chikwawa District
During the Intervention <i>Village Clinic</i>		
• Under-five malaria suspects tested	87,035	78,945
• Confirmed under-five cases	53,992	56,309
• Severe malaria referrals	462	2,165
During Intervention <i>Hospital</i>		
• Admitted under-five malaria cases	2,977	5,258
• Under-five malaria deaths	249	329

Table 4.1 shows data on malaria suspects, confirmed cases and severe malaria referrals during intervention in village clinic, and hospital data on under-five admitted cases and deaths. More confirmed cases, admitted cases and deaths were seen in Chikwawa than in Thyolo.

4.2 The proportion of under-five malaria cases managed by Community health workers and those managed at health centres in Thyolo and Chikwawa districts from 2017 to 2021

In Thyolo district 46.9 % (46,997/100,989) and 53.5% (53,992/100,989) of the under-five malaria cases were seen at the village Clinic and Health Centre respectively in the year 2021 compared to the year 2017 which had 49.7% (13149/26457) and 50.3% (13,308/26,457) of under-five malaria cases seen at village Clinic and Health Centre respectively. Compared with Chikwawa district in the year 2021, 47.1% (16,136/34,248) and 52.9.% (18,112/34,248) of malaria under-five cases were seen at village Clinic and Health Centre respectively compared to 2017 which had 34.3% (7,493/21,865) and 65.7 % (143,72/21,865) of under-five malaria cases respectively. This study

showed that from the year 2017 to 2021, more under-five malaria cases were seen at village clinics in Chikwawa district compared to Thyolo district.

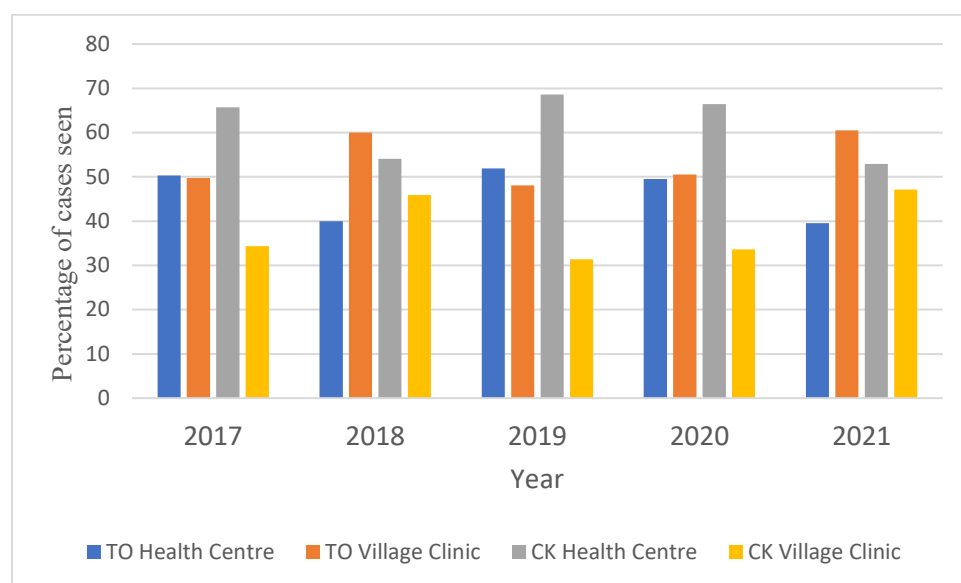


Figure 4.1: The proportion of under-five malaria cases managed by Community health workers and those managed at health centres in Thyolo and Chikwawa districts after the intervention from 2017 to 2021.

Figure 4.1 shows that in both districts, there was an increase in cases managed at village clinics. At village clinic level, there was an increase of 21.7% and 37.3% were observed in Thyolo and Chikwawa districts, respectively. At Health Centre level, decreases of 21.5% and 19.5% were observed in Thyolo and Chikwawa districts, respectively.

Table 4.2: Comparing Village clinic means of Under-five malaria confirmed cases using Independent Samples T Test

	p-value
Under 5 malaria Confirmed Cases	0.603
Severe malaria Cases Referred	0.001
A total of Under 5 malaria suspects were seen/tested	0.241
Note. $H_a \mu_{\text{Chikwawa}} \neq \mu_{\text{Thyolo}}$	

Table 4.2 shows that there was no statistically significant difference in the means of Under 5 malaria confirmed cases between Chikwawa and Thyolo districts ($p = 0.603$). However, there was statistically significant difference in the means of severe malaria cases referred to the Health Centre ($p = \text{value } 0.001$) with a higher means of under-five malaria referral cases in Thyolo district. The results for total Under 5 malaria suspects seen/tested show no statistically significant difference between the two districts ($p = 0.241$).

4.3 Comparison of the under-five malaria deaths trends in Thyolo and Chikwawa districts from 2013 to 2016 before the introduction of community malaria case management and from 2017 to 2021 after the introduction of community malaria case management.

Malaria under-five mortality rate trends had been declining and significantly different in the two study districts (Thyolo and Chikwawa) ($p = 0.036$) from the year 2013 to 2016 before community malaria intervention and after intervention from the year 2017 to 2021. In Thyolo district there had been a significant decline in under-five mortality rates from 72.8 per 100,000 in the year 2013 to 24.7 per 100,000 in the year 2021. Whilst in Chikwawa district there had been a significant decline in under-five mortality rates from 99.4 per 100,000 in the year 2013 to 36.2 per 100,000 in the year 2021 with a $p = \text{value } 0.002$ (Figure 4.1).

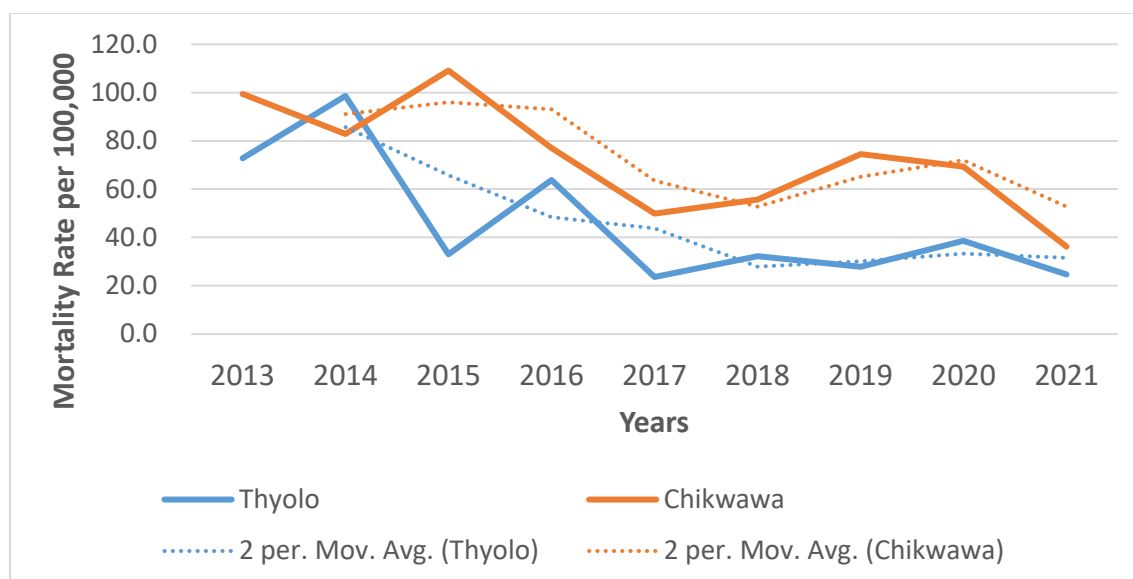


Figure 4.2 Under-five malaria Mortality Rate Trends for Thyolo and Chikwawa Districts from 2013 to 2021

Figure 4.2 shows that the trend for the mortality rate per 100,000 was significantly declining with time and is different in the two study districts ($p = \text{value } 0.0361$ for Thyolo district and $p = \text{value } 0.0054$ for Chikwawa district) and with a slight increase in 2018 and 2019 and a sharp decline in the years 2020 and 2021. However, there was a higher mean of cases in Chikwawa (92.08 per 100,000) than in Thyolo (67.03 per 100,000). There was also a significant decline in the means of mortality rate in Thyolo district before (67.03 per 100,000) and after the introduction of malaria case management (29.38 per 100,000). Likewise, Chikwawa district had a significant decline in means of mortality rate before (92.08 per 100,000) and after malaria community case management (57.12 per 100,000). The figure also forecasts a decline in the trend of mortality rate by a two-year simple moving average.

Table 4.3 Thyolo and Chikwawa districts Under-five malaria Mortality rate trends using Mann-Kandall Trend Test and Sen's slope Time Series analysis from the year 2014 to 2021.

Table 4.3 shows that the under-five mortality rate per 100,000 in Chikwawa and Thyolo Districts, for the years 2013 to 2021 has been declining (S: -16, S: -12 respectively). Chikwawa district has a higher mean (69.32) than Thyolo district (42.79). However, there is a statistically significant decreasing trend (p-value: 0.02587) for the Chikwawa district, unlike the Thyolo district which has no statistically significant decreasing trend (p-value: 0.179).

	Chikwawa District	Thyolo District
Mean	69.326	42.792
Std deviation	22.409	25.903
Kendall's tau	-0.571	-0.429
S	- 16	-12
Var(S)	65.333	65.333
p-value (Two-tailed)	0.02857	0.179
Alpha	0.05	0.05
Sen's slope	-6.577	-4.482

Table 4.4 Thyolo and Chikwawa districts Under-five malaria Case Fatality rate per 100,000 trends using Mann-Kendall Trend Test and Sen's slope Time Series analysis from the year 2013 to 2021.

	Chikwawa District	Thyolo District
Kendall's tau	-0.611	-0.5
S	-22.00	-18.0
Var(S)	92.00	92.00
p-value (Two-tailed)	0.0286	0.0763
Alpha	0.05	0.05
Sen's slope	-0.0067	-0.299

Table 4.4 shows that using the Mann-Kendall trend test there was a statistically declining trend in Under-five Case Fatality Rate (S: -22, p-value:0.0286) in the Chikwawa district from the year 2013 to 2021. For Thyolo district the Under-five Case Fatality Rate trend was declining over the years 2013 to 2021 (S: -18.0) but with no statistically significant decreasing trend in the series (p-value: 0.0763).

Table 4.5: Effect of interventions (deaths and Survival rate) before and after intervention in Chikwawa Districts

Table 4.5 shows the comparison in the effect of interventions (deaths and Survival rate) before and after intervention in Chikwawa District. This shows that there is a statistically significant change ($p = \text{value of } 0.0001$) for Thyolo district after malaria community case management

Chikwawa

Outcome	Before intervention	After intervention	Total	<i>P. value</i>
Dead	320(8.23%)	235(1.93%)	555(3.46%)	0.0001
Survived	3568(91.77%)	11913(98.07%)	15481(96.54%)	
Total	3888(100%)	12148(100%)	16036(100%)	

Table 4.6: Under-five malaria deaths before community health worker intervention and after intervention in Thyolo District.

Thyolo

Outcome	Before intervention	After intervention	Total	<i>P. value</i>
Dead	203(9.59%)	157(6.89%)	360(8.19%)	0.0001
Survived	1914(90.41%)	2121(93.11%)	4035(91.81%)	
Total	2117(100%)	2278(100%)	4395(100%)	

Table 4.6 shows that there is a significant change in Thyolo district with a *p*-value of 0.000. Chikwawa had more deaths before intervention (320) than Thyolo district (203) and the survival rate was higher in Chikwawa (98.07) than in Thyolo (93.11%).

Table 4.7: Attributable Fraction of death before community health worker Intervention (2012-2016) and after intervention (2017-2021) in Thyolo and Chikwawa District.

District	Outcome	Before Intervention	After Intervention	Attributable Fraction (AF)
Chikwawa	Dead	320	235	0.2656 (26.6%)
Thyolo	Dead	203	157	4.7 0.7%)

Table 4.7 shows that there was a higher Attributable Fraction of 26.6% for Chikwawa District compared to Thyolo District with an Attributable Fraction of 22.7%.

4.4 The effect of malaria under-five community malaria case management intervention on under-five malaria deaths and admission using multiple linear regression.

The overall fit of the model was statistically significant as indicated by a *p*-value of 0.002. In terms of the coefficient of determination, the model has a strong positive linear relationship and explains about 64.5% of the variation in the response variable which is the number of deaths in under-five children. The adjusted R^2 value of 0.569 further illustrates that our model can account for approximately 56.9% of the under-five malaria deaths variability, highlighting the included predictors' substantial impact due to community malaria case management intervention. The model shows that there is a significant effect in terms of the intervention towards the number of deaths ($p = 0.002$). However, the model shows that there is no significant difference between

admission and number of malaria deaths ($p = 0.518$) as well as no statistically significant difference between the districts in terms of under-five malaria deaths ($p = 0.75$).

4.5 Comparing the under-five malaria admission trends in Thyolo and Chikwawa districts after the introduction of community malaria case management from 2017 to 2021.

The trends of under-five malaria admitted cases in Thyolo and Chikwawa District have been declining and statistically significantly means difference ($p = 0.034$) between the two districts after the intervention of community malaria case management in under five children by community health workers from the year 2017 to 2021.

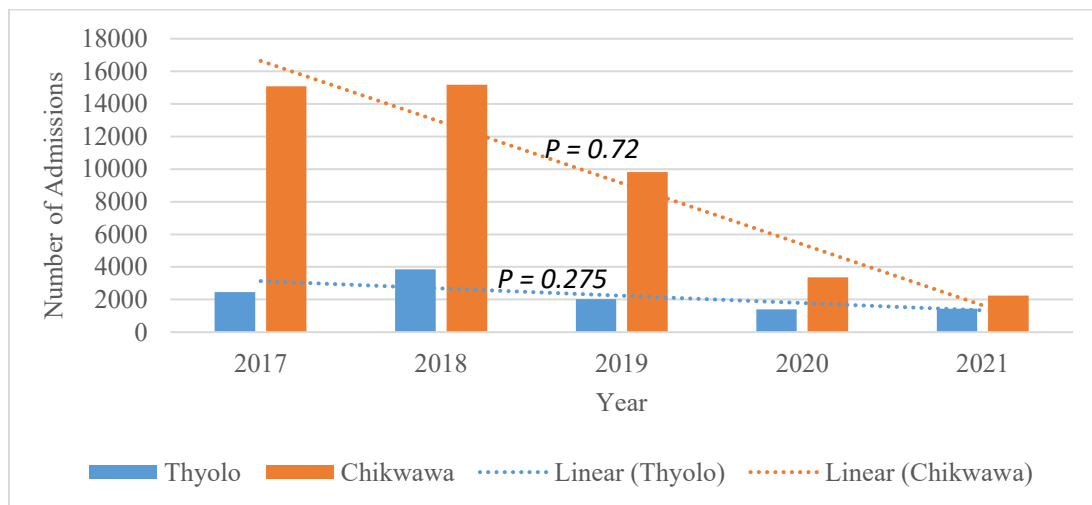


Figure 4.3 A bar chart of Under 5 admitted malaria cases with the trends of admission rates in Thyolo and Chikwawa Districts from 2017 to 2021.

Figure 4.3 shows the decreasing trends in the number of cases over time for both districts with more cases in the Chikwawa district ($M = 9142$) as compared to the Thyolo district ($M = 2235$). There is also a significant mean difference between the two districts ($p = 0.035$).

Table 4.8 Thyolo and Chikwawa districts Under-five severe malaria admission rate per 100,000 trends using Mann-Kandall Trend Test and Sen's slope Time Series analysis from the year 2014 to 2021.

	Chikwawa District	Thyolo District
Mean	2075.500	606.000
Std Deviation	1196.588	480.803
Kendall's tau	0.143	-0.357
S	4	-10
Var(S)	65.333	65.333
p-value (Two-tailed)	0.720	0.275
Alpha	0.05	0.05
Sen's slope	55.500	-32.383

Table 4.8 shows that the under-five severe malaria admission rate had been declining in Thyolo district (S: -10) for the years 2014 to 2021, unlike Chikwawa district which had a slight increase in number of under-five severe malaria admissions (S: 4). However using Sen's slope and Mann Kandal trend test, there is no statistical trend in the series ($p = 0.720$ for Chikwawa district and with $p = 0.275$ for Thyolo district).

CHAPTER FIVE

5.0 DISCUSSION

This study was carried out to determine the proportion of under-five malaria cases managed by CHWs at village clinics and those managed at health facility, comparing mortality trend rates after the introduction of community malaria case management and to compare the admission trends in the two study districts after the introduction of community malaria case management by CHWs.

Results from this study indicate that there is no statistically significant difference in the means of Under-five Malaria confirmed cases at Village clinics between Chikwawa and Thyolo districts ($p = 0.603$). However, the Chikwawa district showed a slight increase in cases over time compared to Thyolo district. This could be due to higher breeding sites for mosquitoes and higher transmission rates in Chikwawa district. Chikwawa district is also more prone to flooding which makes the breeding sites for mosquitoes and increases malaria transmission (Andronescu et al., 2019). The study also shows that from the year 2017 to 2021, 38.5% and 53% of confirmed under-five malaria cases were being attended at the village clinics in their respective catchment area in Chikwawa and Thyolo districts respectively. By reaching patients earlier in disease progression, uncomplicated malaria can be cured before needing more intensive medical care while more severe cases have a greater opportunity to receive timely treatment. The former reduces the stress placed on formal healthcare centres due to an already existing shortage of health professionals to treat uncomplicated malaria patients as well as shrinks the number of patients who progress to severe malaria; the latter allows these same treatment centres access to children that would have otherwise died before being able to engage their health system. This indicates that the community has accepted the community health workers in the management of malaria for the under-five children evidenced by an increase in the number of under-five malaria suspects attending the village clinics. A similar study done in Rwanda indicated that the communities were able to accept the community health workers to do rapid diagnostic tests for malaria. CHWs (Mukanga et al., 2010). Another study aimed at establishing whether Uganda's proximal location to a CHW is associated with the use of CHW services or not. In the study, among 547 households, 64% (338/528) reported using CHWs as the first point of consultation for their febrile children (Mazzi et al., 2019). This is consistent with a study which was done in Uganda on usage and satisfaction with integrated community case management. This study reviewed that communities were satisfied with

community case management care and satisfaction with integrated community case management care, as health services were easily accessed (Miller et al., 2021). Programmes should ensure that CHWs are well located to enable easy access to health care and people also feel that health services are closer to their homes.

Other results from this study based on cases seen at health centres and hospitals were that there is a statistically significant difference ($p < 0.001$) between the group mean of under five children in Chikwawa and Thyolo, with Chikwawa having a higher mean than Thyolo. This study suggests that Chikwawa has seen more malaria cases than Thyolo district in the stipulated period. This might be the case because Chikwawa district has a higher prevalence of malaria than Thyolo hence the higher transmission rate making cases higher.

This study also further revealed that there is a significant decline in the trend of under-five malaria admitted cases over time for Thyolo and Chikwawa districts ($p = 0.034$, t Critical: 2.776). However, Chikwawa district was still showing a high number of admitted under-five malaria cases but declining over time. This study showed a reduction in the number of cases developing severe malaria requiring admission. Under-five malaria cases could develop severe malaria because of delay in treatment among other factors. The delay most of the time comes in due to poor access to treatment and health care as well as delays in referring the patient to a secondary hospital. Most of the severe malaria cases come from remote areas which are far from the health centre and hospital. Any delay in treatment results in patients developing complications that result in deaths. Therefore, with the presence of community health workers in the communities managing malaria cases in under-five children, they can detect and treat malaria early which will delay the development of severe malaria and result in the decrease in the number of admitted cases of malaria. However severe malaria cases are managed at the hospital, unlike uncomplicated malaria which are managed in the community by HSAs as well as health centres by qualified clinicians and nurses. The cases are managed at the hospital because they can do thorough or further investigations and proper monitoring of severe malaria which cannot be done at the community or health Centre. These findings agree with the study done in Rwanda which suggested that both admissions for malaria and laboratory markers of clinical disease among children were rapidly reduced following community-based malaria control efforts through pre- and post-intervention periods. (Sievers et al., 2008). Additionally, this study highlights the problem of over-diagnosis and overtreatment of

malaria in malaria-endemic region. The findings are also consistent with the retrospective study done in Zambia which showed a significant decline of 19% in the number of malaria admissions in children from the year 2015 to 2020 after the introduction of malaria community case management by community health workers (Ashton et al., 2023).

The results of this study also revealed that the mortality rate has been significantly declining ($p = 0.036$) in Thyolo and Chikwawa districts after the implementation of malaria community case management by Community Health Workers. Despite an increase in deaths in Chikwawa district compared to Thyolo, the study found that there is a significant decline in malaria-related deaths among under-five children. The decline in under-five deaths could be attributed to early access to health care in the communities as most malaria deaths were coming from hard-to-reach areas, with long distances to the health facilities. Most malaria complications leading to deaths are due to long distances resulting in delayed treatment. This is also consistent with a retrospective observational study in Zambia where data was collected from the years 2015 to 2020 (Ashton et al., 2023). This study explored the effectiveness of community case management of malaria on severe malaria and inpatient malaria deaths. This study revealed that there was a 19% reduction in severe malaria admissions among children under five (incidence rate ratio [IRR] 0.81, 95% confidence interval [CI] 0.75–0.87, $p < 0.001$) and a 23% reduction in malaria deaths among under-fives (IRR 0.77, 95% CI 0.66–0.91) (Ashton et al., 2023). A similar study was done in Afghanistan looking at trends in malaria after scaling up community-based malaria management. This study revealed a statistically significant decline in death rate by 85% each year (IRR 0.15, 95% CI; $P < 0.001$).

In order for the CHWs to provide patients with the best health care possible, it is crucial to ensure that they get ongoing supervision and mentoring. The community health workers should be provided with relevant adequate resources such as test kits, drugs, and transportation as some areas are mountainous and poorly developed. At the same time, intrinsic factors such as positive patient outcomes, community respect, and recognition by formal health care system and extrinsic factors such as increased scope and workload from original expectations, lack of resources to utilize in their work and supportive relationship between CHWs and supervisors have to be taken into consideration as it enables the CHWs to do better (Ndambo et al., 2022).

The results from this study have also revealed an improvement in the malaria data reporting rate which has been shown by an increase in the number of cases reported by the community health

workers. From the findings, Malawi government will be able to significantly approximate the Sustainable Development Goal (SDG) 3 and 10 to end malaria by 2020 (WHO, 2018) .

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATION

6.1 Conclusion

In this study malaria data for under-five children was collected in selected village clinics, health centres and hospitals in Thyolo and Chikwawa districts of Malawi to investigate the effectiveness of community health workers in malaria health outcomes. The results of this study imply that malaria case management by community health workers is (1) an effective strategy in preventing severe malaria which results in various complications and deaths, especially in areas where access to diagnosis and treatment remains a challenge. The study has also revealed that (2) there was a reduction in the trend of malaria hospital admissions after the introduction of CHWs. Furthermore, the study has also revealed that (3) significantly improve access to health care especially in under-five children who are amongst the vulnerable populations. These results support a need for the continued support of the programme and scale-up to improve further access to malaria diagnosis and treatment. Therefore, there is a need for continued supervision, and mentorship to the community health workers in malaria case management in making sure they are offering quality care like that of the clinicians and nurses. This will help offer health equality for all so that no one is left behind.

6.2. Recommendations and Future Work

Based on the findings of this study the following recommendations are made;

- i. Strengthening the village clinics through supportive supervision, mentorship and continuous flow of supplies.
- ii. There is a need to consider increasing the age limit for patients managed by CHWs to below 10 and other vulnerable populations such as pregnant women as well as those with non-communicable diseases for them to easily access to health care.
- iii. To have a well formalised academic training for these CHWs which will help them with advanced knowledge and skills in the management of common diseases and health promotion.
- iv. Further qualitative research is needed in Malawi to assess the quality of health care offered by the community health workers in comparison to the qualified clinicians and nurses and

to assess community satisfaction in malaria community case management offered by CHWs.

6.3. LIMITATIONS

- i. The sample size was small, only for two districts and therefore the findings cannot be generalised to the entire country of Malawi.
- ii. Some data were recorded from handwritten hospital records, therefore transcription errors of certain variables (e.g. numeric values, diagnoses) due to disparities in spelling, or other human error are possible. To minimise this, source documents were reviewed with the Malaria and Integrated Management of Childhood Illness (IMCI) programme coordinator and the district health information system (dhis2).
- iii. Data was mainly quantitative hence limiting an element of qualitative that could have helped to respond to some qualitative issues for example assessing community acceptability to CHWs on malaria community case management and challenges faced by CHWs.

REFERENCES

- Al-Taiar, A., Jaffar, S., Assabri, A., Al-Habori, M., Azazy, A., Al-Gabri, A., Al-Ganadi, M., Attal, B., & Whitty, C. J. M. (2008). Who develops severe malaria? Impact of access to healthcare, socio-economic and environmental factors on children in Yemen: A case-control study. *Tropical Medicine and International Health*, 13(6), 762–770. <https://doi.org/10.1111/j.1365-3156.2008.02066.x>
- Andronescu, L. R., Buchwald, A. G., Coalson, J. E., Cohee, L., Bauleni, A., Walldorf, J. A., Kandangwe, C., Mzilahowa, T., Taylor, T. E., Mathanga, D. P., & Laufer, M. K. (2019). Net age, but not integrity, may be associated with decreased protection against *Plasmodium falciparum* infection in southern Malawi. *Malaria Journal*, 18(1), 1–7. <https://doi.org/10.1186/s12936-019-2930-8>
- Ashton, R. A., Hamainza, B., Lungu, C., Rutagwera, M. R. I., Porter, T., Bennett, A., Hainsworth, M., Burnett, S., Silumbe, K., Slater, H., Eisele, T. P., & Miller, J. M. (2023). Effectiveness of community case management of malaria on severe malaria and inpatient malaria deaths in Zambia: a dose–response study using routine health information system data. *Malaria Journal*, 22(1), 1–13. <https://doi.org/10.1186/s12936-023-04525-2>
- Bagenda, F., Wesuta, A. C., Stone, G., Ntaro, M., Patel, P., Kenney, J., Baguma, S., Ayebare, D. S., Bwambale, S., Matte, M., Kawungezi, P. C., & Mulogo, E. M. (2022). Contribution of community health workers to the treatment of common illnesses among under 5-year-olds in rural Uganda. *Malaria Journal*, 21(1), 1–6. <https://doi.org/10.1186/s12936-022-04316-1>
- Baltzell, K., Kortz, Teresa BScarr, E., Blair, A., Mguntha, A., Bandawe, G., & Schell, E. (2019). Not all fevers are malaria: a mixed methods study of non-malarial fever management in rural southern Malawi. *Rural and Remote Health*, 19(2).
- Banek, K., Nankabirwa, J., Maiteki-Sebuguzi, C., Diliberto, D., Taaka, L., Chandler, C. I. R., & Staedke, S. G. (2015). Community case management of malaria: Exploring support, capacity and motivation of community medicine distributors in Uganda. *Health Policy and Planning*, 30(4), 451–461. <https://doi.org/10.1093/heapol/czu033>
- Berzosa, P., De Lucio, A., Romay-Barja, M., Herrador, Z., González, V., García, L., Fernández-Martínez, A., Santana-Morales, M., Ncogo, P., Valladares, B., Riloha, M., & Benito, A. (2018). Comparison of three diagnostic methods (microscopy, RDT, and PCR) for the detection of malaria parasites in representative samples from Equatorial Guinea. *Malaria*

- Journal*, 17(1), 1–12. <https://doi.org/10.1186/s12936-018-2481-4>
- Bickton, F. M., & Lillie, T. (2019). Strengthening human resources for health in resource-limited countries: The case of medic to medic in Malawi. *Malawi Medical Journal*, 31(1), 99–101. <https://doi.org/10.4314/mmj.v31i1.17>
- CDC. (n.d.). *Malaria Diagnostic Tests | Malaria | CDC*. Retrieved September 11, 2024, from <https://www.cdc.gov/malaria/hcp/diagnosis-testing/malaria-diagnostic-tests.html>
- CDC. (2020, July 17). *CDC - Malaria - About Malaria - Biology*. <https://www.cdc.gov/malaria/about/biology/index.html>
- CDC, C.-C. for D. C. and. (2021). *CDC - Malaria - Malaria Worldwide - Impact of Malaria*.
- Chilanga, E., Vézina, D. C., Macintosh, H., Mitchell, C., & Cherney, K. (2020). Prevalence and determinants of malaria infection among children of local farmers in Central Malawi. *Malaria Journal*, 1–10. <https://doi.org/10.1186/s12936-020-03382-7>
- Chipukuma, H. M., Halwiindi, H., Zulu, J. M., Azizi, S. C., & Jacobs, C. (2020). Evaluating fidelity of community health worker roles in malaria prevention and control programs in Livingstone District, Zambia-A bottleneck analysis. *BMC Health Services Research*, 20(1), 1–14. <https://doi.org/10.1186/s12913-020-05458-1>
- Conrad, M. D., & Rosenthal, P. J. (2019). Antimalarial drug resistance in Africa: the calm before the storm? *The Lancet Infectious Diseases*, 19(10), e338–e351. [https://doi.org/10.1016/S1473-3099\(19\)30261-0](https://doi.org/10.1016/S1473-3099(19)30261-0)
- Conroy, A., Datta, D., & John, C. C. (2019). Causes Severe Malaria and Its Complications in Children. *BMC Medicine*, 17(1), 10–13.
- Flannery, E. L., Kangwanransan, N., Chuenchob, V., Roobsoong, W., Fishbaugher, M., Zhou, K., Billman, Z. P., Martinson, T., Olsen, T. M., Schäfer, C., Campo, B., Murphy, S. C., Mikolajczak, S. A., Kappe, S. H. I., & Sattabongkot, J. (2022). Plasmodium vivax latent liver infection is characterized by persistent hypnozoites, hypnozoite-derived schizonts, and time-dependent efficacy of primaquine. *Molecular Therapy Methods and Clinical Development*, 26(September), 427–440. <https://doi.org/10.1016/j.omtm.2022.07.016>
- Gaston, R. T., & Ramroop, S. (2020). Prevalence of and factors associated with malaria in children under five years of age in Malawi, using malaria indicator survey data. *Heliyon*, 6(5), e03946. <https://doi.org/10.1016/j.heliyon.2020.e03946>
- Global fund. (2020). *Malawi integrated community case management | Severe Malaria*

- Observatory*. <https://www.severemalaria.org/countries/malawi/malawi-integrated-community-case-management>
- GoM, M. (2020). Guidelines for treatment of Malaria In Malawi. *Report, August*.
- Hu, J., Zhang, C., Wang, S., Chen, X., Hu, J., & Liu, X. (2021). Accuracy of rapid diagnostic test to diagnose malaria in children under 5 years of age, a meta-analysis. *Diagnostic Microbiology and Infectious Disease*, 100(2), 115351. <https://doi.org/10.1016/J.DIAGMICROBIO.2021.115351>
- Ippolito, M. M., Kamavu, L. K., Kabuya, J. B., Tente, C., Chileshe, E., Wapachole, M., Thuma, P. E., Muleba, M., Chaponda, M., Mulenga, M., & Moss, W. J. (2018). Risk factors for mortality in children hospitalized with severe malaria in northern Zambia: A retrospective case-Control study. *American Journal of Tropical Medicine and Hygiene*, 98(6), 1699–1704. <https://doi.org/10.4269/ajtmh.17-1017>
- Ippolito, M. M., Moser, K. A., Kabuya, J.-B. B., Cunningham, C., & Juliano, J. J. (2021). Antimalarial Drug Resistance and Implications for the WHO Global Technical Strategy. *Current Epidemiology Reports*, 8(2), 46–62. <https://doi.org/10.1007/s40471-021-00266-5>
- Jourdain, F., Picard, M., Sulesco, T., Haddad, N., Harrat, Z., Sawalha, S. S., Günay, F., Kanani, K., Shaibi, T., Akhramenko, D., Sarih, M., Velo, E., Paronyan, L., Pajovic, I., Faraj, C., Sikharulidze, I., Putkaradze, D., Maric, J., Bosevska, G., ... Robert, V. (2018). Identification of mosquitoes (Diptera: Culicidae): an external quality assessment of medical entomology laboratories in the MediLabSecure Network. *Parasites and Vectors*, 11(1), 1–7. <https://doi.org/10.1186/s13071-018-3127-7>
- Kaunda-Khangamwa, B. N., Van Den Berg, H., McCann, R. S., Kabaghe, A., Takken, W., Phiri, K., Van Vugt, M., & Manda-Taylor, L. (2019). The role of health animators in malaria control: A qualitative study of the health animator (HA) approach within the Majete malaria project (MMP) in Chikwawa District, Malawi. *BMC Health Services Research*, 19(1), 1–16. <https://doi.org/10.1186/s12913-019-4320-x>
- Kilov, K., Hildenwall, H., Dube, A., Zadutsa, B., Banda, L., Langton, J., Desmond, N., Lufesi, N., Makwenda, C., & King, C. (2021). Integrated Management of Childhood Illnesses (IMCI): A mixed-methods study on implementation, knowledge and resource availability in Malawi. *BMJ Paediatrics Open*, 5(1). <https://doi.org/10.1136/bmjpo-2021-001044>
- Loha, E., Deressa, W., Gari, T., Balkew, M., Kenea, O., Solomon, T., Hailu, A., Robberstad, B.,

- Assegid, M., Overgaard, H. J., & Lindtjørn, B. (2019). Long-lasting insecticidal nets and indoor residual spraying may not be sufficient to eliminate malaria in a low malaria incidence area: Results from a cluster randomized controlled trial in Ethiopia. *Malaria Journal*, 18(1), 1–15. <https://doi.org/10.1186/s12936-019-2775-1>
- Mahmud, R., Lim, Y. A. L., & Amir, A. (2017). Ectoparasites of Medical Importance. In *Medical Parasitology*. https://doi.org/10.1007/978-3-319-68795-7_13
- Marita, E., Langat, B., Kinyari, T., Igunza, P., Apat, D., Kimori, J., Carter, J., Kiplimo, R., & Muhula, S. (2022). Implementation of community case management of malaria in malaria endemic counties of western Kenya: are community health volunteers up to the task in diagnosing malaria? *Malaria Journal*, 21(1), 1–7. <https://doi.org/10.1186/s12936-022-04094-w>
- Mazzi, M., Bajunirwe, F., Aheebwe, E., Nuwamanya, S., & Bagenda, F. N. (2019). Proximity to a community health worker is associated with utilization of malaria treatment services in the community among under-five children: A cross-sectional study in rural Uganda. *International Health*, 11(2), 143–149. <https://doi.org/10.1093/inthealth/ihy069>
- Mhango, P., Malata, M. P., Chipeta, E., Sixpence, A., Taylor, T. E., Wilson, M. L., Cohee, L. M., Mangani, C., & Mathanga, D. P. (2023). Barriers to accessing malaria treatment amongst school-age children in rural Malawi. *Malaria Journal*, 22(1). <https://doi.org/10.1186/s12936-023-04695-z>
- Miller, J. S., Patel, P., McCarthy, S. M., Wesuta, A. C., Matte, M., Ntaro, M., Bwambale, S., Kenney, J., Stone, G. S., & Mulogo, E. M. (2021). Usage of and satisfaction with Integrated Community Case Management care in western Uganda : a cross - sectional survey. *Malaria Journal*, 1–6. <https://doi.org/10.1186/s12936-021-03601-9>
- Mukanga, D., Tibenderana, J. K., Kiguli, J., Pariyo, G. W., Waiswa, P., Bajunirwe, F., Mutamba, B., Counihan, H., Ojiambo, G., & Kallander, K. (2010). Community acceptability of use of rapid diagnostic tests for malaria by community health workers in Uganda. *Malaria Journal*, 9(1), 1–9. <https://doi.org/10.1186/1475-2875-9-203>
- Napier, H. G., Baird, M., Wong, E., Walwyn-Jones, E., Garcia, M. E., Cartagena, L., Mngadi, N., Vanisaveth, V., Sengsavath, V., Vilay, P., Thongpiou, K., Visser, T., & Cohen, J. M. (2021). Evaluating vertical malaria community health worker programs as malaria declines: Learning from program evaluations in Honduras and Lao pdr. *Global Health Science and Practice*, 16,

- S98–S110. <https://doi.org/10.9745/GHSP-D-20-00379>
- Ndambo, M. K., Munyaneza, F., Aron, M. B., Nhlema, B., & Connolly, E. (2022). Qualitative assessment of community health workers' perspective on their motivation in community-based primary health care in rural Malawi. *BMC Health Services Research*, 22(1), 1–13. <https://doi.org/10.1186/s12913-022-07558-6>
- NMCP. (2017). *Malawi Malaria Indicator Survey 2017*. 2.
- NSO. (2019). *MALAWI POPULATION AND HOUSING CENSUS REPORT-2018 2018 Malawi Population and Housing Main Report* (Issue May). [http://www.nsomalawi.mw/images/stories/data_on_line/demography/census_2018/2018 Malawi Population and Housing Census Main Report.pdf](http://www.nsomalawi.mw/images/stories/data_on_line/demography/census_2018/2018_Malawi_Population_and_Housing_Census_Main_Report.pdf)
- Nsona, H., Mtimuni, A., Daelmans, B., Callaghan-Koru, J. A., Gilroy, K., Mgalula, L., Kachule, T., & Zamasiya, T. (2012). Scaling up integrated community case management of childhood illness: Update from Malawi. *American Journal of Tropical Medicine and Hygiene*, 87(SUPPL.5), 54–60. <https://doi.org/10.4269/ajtmh.2012.11-0759>
- O'Meara, W. P., Noor, A., Gatakaa, H., Tsofa, B., McKenzie, F. E., & Marsh, K. (2009). The impact of primary health care on malaria morbidity - Defining access by disease burden. *Tropical Medicine and International Health*, 14(1), 29–35. <https://doi.org/10.1111/j.1365-3156.2008.02194.x>
- Onchiri, F. M., Pavlinac, P. B., Singa, B. O., Naulikha, J. M., Odundo, E. A., Farquhar, C., Richardson, B. A., John-Stewart, G., & Walson, J. L. (2015). Frequency and correlates of malaria over-treatment in areas of differing malaria transmission: A cross-sectional study in rural Western Kenya. *Malaria Journal*, 14(1), 1–9. <https://doi.org/10.1186/s12936-015-0613-7>
- Pallas, S. W., Minhas, D., Pérez-Escamilla, R., Taylor, L., Curry, L., & Bradley, E. H. (2013). Community health workers in low- and middle-income countries: What do we know about scaling up and sustainability? *American Journal of Public Health*, 103(7), 74–82. <https://doi.org/10.2105/AJPH.2012.301102>
- Paniker, C. (2013). Chapter-04 Intestinal, Oral, and Genital Flagellates. In *Paniker's Textbook of Medical Parasitology*. https://doi.org/10.5005/jp/books/12069_4
- Phiri, T. B., Kaunda-Khangamwa, B. N., Bauleni, A., Chimuna, T., Melody, D., Kalengamaliro, H., Sande, J. H., Nsona, H. K., & Mathanga, D. P. (2016). Feasibility, acceptability and

- impact of integrating malaria rapid diagnostic tests and pre-referral rectal artesunate into the integrated community case management programme. A pilot study in Mchinji district, Malawi. *Malaria Journal*, 15(1), 1–8. <https://doi.org/10.1186/s12936-016-1237-2>
- Schumacher, R. F., & Spinelli, E. (2012). Malaria in children. *Mediterranean Journal of Hematology and Infectious Diseases*, 4(1). <https://doi.org/10.4084/MJHID.2012.073>
- Sievers, A. C., Lewey, J., Musafiri, P., Franke, M. F., Bucyibaruta, B. J., Stulac, S. N., Rich, M. L., Karema, C., & Daily, J. P. (2008). *Reduced paediatric hospitalizations for malaria and febrile illness patterns following implementation of community-based malaria control programme in rural Rwanda*. 268, 1–9. <https://doi.org/10.1186/1475-2875-7-167>
- SMO. (2022). *Malawi integrated community case management | Severe Malaria Observatory*. <https://www.severemalaria.org/countries/malawi/malawi-integrated-community-case-management>
- Tizifa, T. A., Kabaghe, A. N., McCann, R. S., van den Berg, H., Van Vugt, M., & Phiri, K. S. (2018). Prevention Efforts for Malaria. *Current Tropical Medicine Reports*, 5(1), 41–50. <https://doi.org/10.1007/s40475-018-0133-y>
- Turap, T., Merupakan, T. B., Lebih, T. B., & Turap, T. D. (2018). *WHO guideline on health policy and system support to optimize community health worker programmes WHO*.
- Turney, S. (2022). *Central Limit Theorem | Formula, Definition & Examples*. <https://www.scribbr.com/statistics/central-limit-theorem/>
- UNICEF. (2022). *Malaria in Africa - UNICEF DATA*. <https://data.unicef.org/topic/child-health/malaria/>
- UNICEF. (2021). *Village clinic stops preventable deaths in children | UNICEF Malawi*. <https://www.unicef.org/malawi/stories/village-clinic-stops-preventable-deaths-children>
- UNSDG. (2022). *UNSDG | Leave No One Behind*. <https://unsdg.un.org/2030-agenda/universal-values/leave-no-one-behind>
- Van Den Berg, M., Ogutu, B., Sewankambo, N. K., Biller-Andorno, N., & Tanner, M. (2019). RTS,S malaria vaccine pilot studies: Addressing the human realities in large-scale clinical trials. *Trials*, 20(1), 1–4. <https://doi.org/10.1186/s13063-019-3391-7>
- WHO. (2018). Malaria: fact sheet on Sustainable Development Goals (SDGs): health targets. *World Health Organization*, 1, 1–5. <https://iris.who.int/handle/10665/340834>
- WHO. (2021a). Global technical strategy for malaria 2016-2030, 2021 update. In *World Health*

- Organization. <https://apps.who.int/iris/rest/bitstreams/1357541/retrieve>
- WHO. (2021b). WHO malaria terminology. *Global Malaria Programme*, 1–38. https://apps.who.int/iris/bitstream/handle/10665/208815/WHO_HTM_GMP_2016.6_eng.pdf?sequence=1
- WHO. (2021c, April 12). *What do we know about community health workers? A systematic review of existing reviews*. <https://www.who.int/publications/i/item/what-do-we-know-about-community-health-workers-a-systematic-review-of-existing-reviews>
- WHO. (2021d, July 26). *Malaria*. <https://www.who.int/news-room/fact-sheets/detail/malaria>
- WHO. (2022a). *Chronic staff shortfalls stifle Africa's health systems: WHO study* | WHO | Regional Office for Africa. <https://www.afro.who.int/news/chronic-staff-shortfalls-stifle-africas-health-systems-who-study>
- WHO. (2022b). *Estimated malaria mortality rate (per 100 000 population)*. <https://www.who.int/data/gho/indicator-metadata-registry/imr-details/16>
- WHO. (2022c). WHO Guidelines for malaria - 25 November 2022. *World Health Organization*, 1–396. <https://app.magicapp.org/#/guideline/6832>
- WHO. (2022d, December 8). *Malaria*. <https://www.who.int/news-room/fact-sheets/detail/malaria>
- WHO Report. (2018). WHO | The World malaria report 2018. *Who*, 22. www.who.int/malaria%0Ahttps://apps.who.int/iris/bitstream/handle/10665/275867/9789241565653-eng.pdf?ua=1%0Ahttps://www.who.int/malaria/publications/world-malaria-report-2018/en/; consulté le 22/03/2019%0Ahttps://www.who.int/malaria/media/world-malaria-rep

APPENDICES

Appendix A: Village clinic Checklist

District Malaria Research Village Clinic Data collection Tool

Year :

District Name:

Jan - Mar

	Health Centre Name	Under 5 Malaria Cases	Severe Malaria Cases Referred	Malaria Negative Test
1				
2				
3				
4				
5				
6				
7				
8				

April - June

	Health Centre Name	Under 5 Malaria Cases	Severe Malaria Cases Referred	Malaria Negative Test
1				
2				
3				
4				
5				
6				
7				
8				

July - Sept

	Health Centre Name	Under 5 Malaria Cases	Severe Malaria Cases Referred	Malaria Negative Test
1				
2				
3				
4				
5				
6				
7				
8				

Oct - Dec

	Health Centre Name	Under 5 Malaria Cases	Severe Malaria Cases Referred	Malaria Negative Test
1				
2				
3				
4				
5				
6				
7				
8				

Appendix B: Health Centre Checklist

MALARIA RESEARCH DATA COLLECTION TOOL

Year:

District Name:

HEALTH CENTRE DATA

Jan - Mar

		UNDER 5 MALARIA CASES	OVER 5 MALARIA CASES
	HEALTH CENTRE NAME		
1			
2			
3			
4			
5			
6			
7			
8			

April - June

		UNDER 5	OVER 5 MALARIA CASES
	HEALTH CENTRE NAME		
1			
2			
3			
4			
5			
6			
7			
8			

July - Sept

		UNDER 5	OVER 5 MALARIA CASES
	HEALTH CENTRE NAME		
1			
2			
3			
4			
5			
6			
7			
8			

Oct - Dec

		UNDER 5	OVER 5 MALARIA CASES
	HEALTH CENTRE NAME		
1			
2			
3			
4			
5			
6			
7			
8			

Appendix C: Hospital Checklist

MALARIA RESEARCH DATA COLLECTION TOOL

Year :

District:

Jan to March

Hospital Data

		UNDER 5 MALARIA ADMITTED CASES	Under 5 Malaria deaths	Over 5 malaria deaths	TOTAL DEATHS all causes	OVER 5 MALARIA ADMITTED CASES
	HOSPITAL NAME					
1						
2						
3						

April to June

Hospital Data

		UNDER 5 MALARIA ADMITTED CASES	Under 5 Malaria deaths	Over 5 malaria deaths	TOTAL DEATHS all causes	OVER 5 MALARIA ADMITTED CASES
	HOSPITAL NAME					
1						
2						
3						

July to Sept

Hospital Data

		UNDER 5 MALARIA ADMITTED CASES	Under 5 Malaria deaths	Over 5 malaria deaths	TOTAL DEATHS all causes	OVER 5 MALARIA ADMITTED CASES
	HOSPITAL NAME					
1						
2						
3						

Oct to Dec

Hospital Data

		UNDER 5 MALARIA ADMITTED CASES	Under 5 Malaria deaths	Over 5 malaria deaths	TOTAL DEATHS all causes	OVER 5 MALARIA ADMITTED CASES
	HOSPITAL NAME					
1						
2						
3						

Appendix D: Institution approval letter



**THE UNIVERSITY OF ZAMBIA
SCHOOL OF VETERINARY MEDICINE
OFFICE OF THE DEAN (POSTGRADUATE)**

Telephone: 293727
Telegrams: UNZA LUSAKA
Telex: UNZALU ZA 44370
Fax: 293727/253952
School Fax: 293727
Vet. Clinic Telephone: 291515

P.O. Box 32379
Lusaka, Zambia

Your Ref:

Our Ref:

=====

13th December 2022

Mwayi Pandame
Department of Paraclinical Studies
School of Veterinary Medicine
University of Zambia
P. O. Box 32379
LUSAKA

Dear Pandame

SUBJECT: APPROVAL OF RESEARCH PROPOSAL

At the meeting of the School Board of Graduate Studies held on 7th December, 2022, your research proposal entitled: *"Exploring the impact of task shifting to Community Health Workers on Malaria case management in Thyolo and Chikwawa district of Malawi"* was tabled and discussed. I am therefore, pleased to inform you that the research proposal was subsequently approved by the Board.

On behalf of the Board, I wish you success as you apply for ethical approval and carry on with your research activities.

Yours sincerely

Dr. Chisoni Mumba

ASSISTANT DEAN (PG), SCHOOL OF VETERINARY MEDICINE

Cc *Director, DRGS*
 Dean, School of Veterinary Medicine
 Head, Paraclinical Studies ✓
 File

Appendix E: Ethical Approval by Malawi National Health Research Committee

CERTIFICATE OF ETHICS APPROVAL

This is to certify that the National Health Science Research Committee
has reviewed and approved the study titled:

Study Title: Protocol # 23/03/4000: Exploring Effects of Community Case management of Malaria by Community Health Workers on Malaria Health Outcomes in Thyolo and Chikwawa Districts of Malawi from 2017 to 2021

Investigator: Mwayi Pendame

StartDate: 06/04/2023 End Date: 05/04/2024

Date of issue: 06/04/2023

Dr. Collins Mitambo
For: Chairperson-NHSRC

Mr. Billy Nyambalo
NHSRC -Administrator

National Health Sciences Research
Committee
2023 -04- 06
APPROVE

Appendix F: Permission to conduct research by Thyolo District Health Office

Telephone: + 265 1473 411
Facsimile: + 265 1473 409
Email:

All Communications should be
addressed to:
The Director of Health and Social
Services



In reply please quote: MP/1/01/23
Thyolo District Council
P/Bag 5
Thyolo.
Malawi

09/03/ 2023

To: Whom it may concern

Recommendation letter for **Mwayi Pendame** to undertake a study in Thyolo District titled "*Exploring the impact of task shifting to community health workers on Malaria case management* "

The above matter refers.

Thyolo District Health office would like to pledge its support to **Mwayi Pendame** to undertake the above-mentioned study in Thyolo District as a requirement to earn his Master of science in Tropical Infectious Disease and Zoonoses

The study will locate intervention points where most malaria cases are managed and this will help us channel resources to these facilities in order to prevent Malaria better than before.

Any assistance rendered to **Mwayi Pendame** pertaining to this authorization shall be greatly appreciated.

Sincerely yours,

A handwritten signature in blue ink, appearing to read "Arnold Jumbe".

Dr Arnold Jumbe (HEAL Fellow, MBA, MBBS, BSc)
Director of Health and Social-welfare Services
arnoldnoxy@yahoo.co.uk, +265888360003, +265991884755

Appendix F: Permission to conduct research by Chikwawa District Health Office

Telephone: (+265) 01420266
Fax: (+265) 01420264
Email:chikwawadhss@gmail.com



Communications should be addressed to:
Director of Health and Social Services
Chikwawa District Hospital
P.O Box 32
Chikwawa

24 February 2023

The Chairperson
National Health Sciences Research Committee

Dear Sir/Madam,

SUPPORT LETTER FOR THE STUDY "EXPLORING THE EFFECT OF TASK SHIFTING TO COMMUNITY HEALTH WORKERS ON MALARIA CASE MANAGEMENT IN UNDERFIVE CHILDREN IN THYOLO AND CHIKWAWA DISTRICTS OF MALAWI FROM 2017 TO 2021"

I have written this letter in support of the above-named research study. The study will generate insightful evidence into the impact of community health workers in the management of malaria at the community level. Furthermore, the study will generate recommendations on how Chikwawa district council and the country at large can improve community work and collaborations to improve malaria treatment at community level. Therefore, this is expected to reduce malaria morbidity and mortality in Chikwawa and the country as a whole.

The Chikwawa district council expects to be appraised on a regular basis on the progress during the implementation of the study protocol. Furthermore, the council expects that the study investigator will disseminate the final study results to all stakeholders in the district at the completion of the study.

Dr. Wamaka Msopole
For: Director of Health and Social Services

