**AN INFORMETRIC ANALYSIS OF MALARIA RESEARCH IN ZAMBIA, 1961-2016**

**By**

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**A Dissertation Submitted to the University of Zambia in Partial Fulfillment of the Requirement for the Award of a Master of Library and information Science (MLIS)**

**The University of Zambia**

**Lusaka**

**2019**

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## DECLARATION

I Namukale Chifunda, do hereby declare that this dissertation represents my own work, except where I have indicated my acknowledgement to other sources and that it has not been submitted for a degree by anyone else at the University of Zambia or at any other University for the purpose of acquiring a degree.

Signature of author.....................................................................................................................

Date: ........................................................................................................................................

# APPROVAL

This dissertation of Namukale Chifunda has been approved in fulfilling the partial requirement for the award of the degree of Master of Library and Information Sciences (MLIS) by the University of Zambia.

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Supervisor …………………………… signature ……………………………..Date…………

# DEDICATION

I dedicate this achievement to my husband Emmanuel Sichiliango, my daughters Chingo and Namel Ngochi and the Chifunda family for their warm love, support and understanding.

# ACKNOWLEDGEMENT

I give my utmost appreciation and thanks to God Almighty who granted me the Grace throughout my studies.

First and foremost I wish to acknowledge my supervisor Dr. A. Akakandelwa for his professional guidance and knowledge shown to me from the topic identification and in the process of writing this dissertation. His comments and correction of my work gave me motivation to work hard.

Profound gratitude also goes to Mrs. Loveness Chongo Silwimba and Bishop Fred Mwale (PhD) whose contributions managed to boost the process to its successful accomplishment.

Special thanks go to ZAMISE Management, my lecturers, course mates and friends for the support they rendered to me. I am grateful to you all.

To my loving husband and children, your support, encouragement and great sacrifice helped me not to give up.

Lastly, my thanks go to the people who supported me emotionally, financially, socially, physically and spiritually and may the Almighty God reward you all for what you did for me.

# ABSTRACT

The study focused on an informetric analysis of malaria research in Zambia. This study aimed to investigate research output on malaria in Zambia, from 1961 to 2016. The specific objectives were to investigate the research output on malaria in Zambia in PubMed/Medline from 1961 to 2016, identify the organisations conducting research on malaria in Zambia from 1961 to 2016, explore authorship collaboration in malaria research from 1961 to 2016 and identify the core journal in which research on malaria is published from 1961 to 2016. The quantitative approach was used when designing and planning this study. The study made use of informetric approaches, which is citations analysis by obtaining 440 publications of malaria in Zambia in PubMed/Medline, to fulfill its general objective. These publications were produced between 1961 and 2016. Research output on malaria in Zambia was highest in the period 2011 to 2016 with the percentage of 45.2 (199) publications, whilst the lowest being from the period 1961 to 1975 with the percentage of 5 (2). Organisations conducting research on malaria in Zambia, such as Medical Research Institution produced the majority at 41.6% (183) of these publications, while Government of the Republic of Zambia like Ministry of Health, Chainama Hospital, Ndola Central Hospital, malaria research publications were the lowest at 2.7%(12). The authorship collaboration distribution patterns on articles on Malaria showed that 54.5% (240) were co-authored by groups of more than five people, with the lowest of four authorship collaboration pattern at 8.6 %(38) of the published articles on Malaria. The study revealed highest number of malaria publications was the Malaria Journal with 23.0% (101) and the lowest journals were the Annals of Tropical Medicine and the Parasitology Journal with 1.1% (5) each. The distribution of the research publications on aspects of Malaria indicated that a significant number of authors 54.3% (239) authored on general and unspecified aspects on malaria, while the lowest 0.5% (2) focused on the symptoms of malaria. Based on the findings of the study, the following are some of the recommendations; more local research publications must be conducted, all types of authors should contribute equally to the authorship patterns in malaria research and more local authors must be contributing to the journals in which research on malaria is published.

**Key words:** Malaria, citation analysis, Zambia

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# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AMDR | Antimalarial Drug Resistance |
| BICOMB | Bibliographic Items Co-occurrence Matrix Builder |
| CBOH | Central Board of Health |
| CABI | Commonwealth Agricultural Bureaux International |
| CDCs | Centers for Disease Control and Prevention |
| CNKI | China National Knowledge Infrastructure |
| CPP | Citations Per Paper |
| CSIR | Council for Scientific and Industrial Research |
| CSO | Central Statistical Office |
| DBT | Department of Biotechnology |
| DDT | Dichloro-Diphenyl-Trichloroethane |
| ICMR | Indian Council for Medical Research |
| MDG | Millennium Development Goals |
| MCDMCH | Ministry of Community Development Mother and Child Health |
| MiPL | Malaria in Pregnancy Library |
| MIS | Malaria Indicator Survey |
| MOH | Ministry of Health |
| NHQ | Number of High-Quality Papers |
| NHMIS | National Health Management Information System |
| NMCC | National Malaria Control Centre |
| NMCP | National Malaria Control Program |
| NMESP | National Malaria Elimination Strategic Plan |
| NMSP | National Malaria Strategic Plan |
| RQI | Relative Quality Index |
| SCI | Science Citation Index |
| SGML | Standard Generalised Markup Language |
| TDB | Tropical Diseases Bulletin |
| TGCS | Total Local Citation Score |
| TLCS | Total Local Citation Score |
| TLCR | Total Global Citation Score |

| | |
|---|---|
| UCL | University College London |
| UK | United Kingdom |
| UNDP | United Nations Development Program |
| UNICEF | United Nations International Children Education Fund |
| USAID | United States Agency for International Development |
| USA | United State of America |
| WHO | World Health Organization |
| WoS | Web of Science |
| ZCSO | Zambia Central Statistical Office |
| ZDHS | Zambia Demographic and Health Survey |

# CHAPTER ONE: INTRODUCTION

## 1.1    Overview

This study was an informetric analysis of malaria research in Zambia. This chapter presented information on the background of the study, statement of the problem, objectives and the research questions to be answered in the study. Additionally, other areas covered in the chapter included the significance of the study, the theoretical framework and operational definitions of key terms.

## 1.2    Background to the Study

Malaria is a serious, relapsing infection in humans, characterized by periodic attacks of chills and fever, anemia, splenomegaly (enlargement of the spleen), and often fatal complications. It is caused by one-celled parasites of the genus plasmodium that are transmitted to humans by the bite of anopheles mosquitoes. Malaria can occur in temperate regions, but it is most common in the tropics and subtropics. In many parts of Sub-Saharan Africa, entire populations are infected more or less constantly. Malaria is also common in Central America, the northern half of South America, and in South and Southeast Asia. The disease also occurs in countries bordering on the Mediterranean, in the Middle East, and in East Asia. In Europe, North America, and the developed countries of East Asia, malaria is still encountered in travelers arriving or returning from affected tropical zones. Annual cases of malaria worldwide are estimated at 250 million, with more than one million deaths resulting most of them young children in Africa (Encyclopedia Britannica, 2015 and Dawson, 2002).

UNICEF Zambia (2017) Zambia has an estimated population of 17.6 million by 2016 with 3.05% growth rate and 40% of the population residing in urban areas and 60% in rural areas. The country consists of ten provinces and 106 districts (recent demarcations have increased the number of districts from 72 original districts). Recently, Zambia has made progress towards the Millennium Development Goals (MDG) targets for 2015. According to UNICEF, under-five mortality has fallen from 93 deaths per 1,000 live births in 1990 to 41 deaths per 1,000 live births in 2016 showing that there is progress in reducing child mortality due to research and studies

which have been made available in PubMed/Medline on malaria about the preventive measures to be taken (UNICEF, United Nations Population Division and United Nations Statistics Division). Eighty-six percent of children complete primary school, (Zambia Central Statistical Office and Zambia Demographic and Health Survey 2007; UNICEF Zambia 2017 and NMCC, 2005).

Zambia boasts of a relatively stable and efficient government and political system. Following the change of government in October 2011, the Zambian Government re-aligned and split health portfolio functions between the Ministry of Health (MOH) at the central and provincial level and the Ministry of Community Development Mother and Child Health (MCDMCH) at the district level through community. The MOH and MCDMCH have conducted researches on malaria in Zambia. According to the report from the MOH and MCDMCH, malaria is a major public health problem in Zambia. It is one of the leading causes of morbidity and the second highest cause of mortality in the general population and children in particular (NMCC/CBOH, 2000). Although there are signs of improvement, malaria continues to be a major cause of morbidity and mortality in Zambia. The entire Zambian population is at risk of malaria, and control of the disease remains one of the government's highest priorities. In 2013, the National Health Management Information System reported nearly 4.9 million clinical and laboratory-confirmed cases of malaria, an increase of 1.5 million from 2009. Malaria transmission in Zambia occurs throughout the year with the peak during the rainy season, between November and April. The disease remains endemic but with wide variation in prevalence of infection across districts. Plasmodium falciparum is the major source of infection. Currently, Zambia's national malaria control program is aiming to provide vector control to 100 percent of households and persons at risk in targeted areas by 2016 (NHMIS 2013 and MOH 2010)

It is for this reason that the Zambian Government is making attempts to try and stop the spread of the disease and reverse the situation at hand; through the development and implementation of National Malaria Strategic Plans and many other intervention measures. Since the fourth National Malaria Strategic Plan of 2017–2021, the efforts of the Government of the Republic of Zambia in conjunction with many partners have been focused on providing equitable access to cost effective, high quality health services as close to the family as possible. The plan further wants to find ways of eliminating local malaria infection and disease in Zambia by 2021 and

maintain malaria free status and prevents reintroduction and importation of malaria into areas where the disease has been eliminated. In line with these efforts, the Ministry of Health (MOH) and National Malaria Control Centre (NMCC), has developed a further National Malaria Elimination Strategic Plan (NMESP) 2017–2021 aimed at significantly sustaining the gains achieved during initial scale-up efforts of malaria control interventions toward the achievement of the national vision of a malaria-free Zambia (NMCC, 2016; MoH, 2010).

## 1.3 Statement of the Problem

Scientific journals play a vital role in the dissemination of research results through publications, whose importance in advancing the careers of scientists increases the possibilities of these journals influencing research priorities (Momen, 2004). Generally, serials and particularly journals are progressively becoming major sources of malaria information thereby assuming the position of useful and reliable tools that can be employed in fighting the disease. These sources have remarkably reached, influenced and provided the means to, as well as play a major role towards successfully leading a campaign against the pandemic. However, the visibility and impact of malaria journals as well as the identification of core resources of malaria research in Africa and in Zambia in particular, are aspects that have not been adequately explored in PubMed/Medline. It is for this reason that the researcher decided to undertake this informetric analysis on the subject in order to know the visibility of research findings in Zambia in PubMed/Medline.

## 1.4 Objectives of the Study

The main objective of this study was to investigate research output on malaria in Zambia, from 1961 to 2016 May.

The Specific objectives of the study were to:

1. investigate the research output on malaria in Zambia in PubMed/Medline from 1961 to 2016
2. identify the organisations conducting research on malaria in Zambia from 1961 to 2016
3. explore authorship pattern in malaria research from 1961 to 2016
4. identify the core journals in which research on malaria is published from 1961 to 2016
5. identify the major research areas on malaria in Zambia from 1961 to 2016

## 1.5 Research Questions

This study was guided by the following research questions:

1. What is the research output in malaria in Zambia in PubMed/Medline from 1961 to 2016?
2. Which organisations conduct research on malaria in Zambia from 1961 to 2016?
3. What are the authorship patterns on malaria in Zambia from 1961 to 2016?
4. What are the core journals in which research on malaria is published from 1961 to 2016?
5. What are the major research areas on malaria in Zambia from 1961 to 2016?

## 1.6 Significance of the Study

Few informatics studies have been conducted in Zambia. According to Spilsbury (2000) the benefits of research evaluative studies are the increased efficiency of research investment, transparency in how and why investment decisions are made and accountability to stakeholders in terms of the impacts produced from the funds provided. Therefore, the study's purpose was to add new knowledge. The findings of this study should be useful to other Informetricians who have an interest in these research methods. This study was meant to popularize informetrics as a research tool as well as encourage further studies into malaria using the same research method. To policy makers, e.g. Ministry of Health Zambia, World Health Organization (WHO), United Nations Development Program (UNDP), United Nations International Children Education Fund (UNICEF), the study should help them in their decision-making processes as pertains to research activities and funding on malaria research in Zambia. Systematic reviews of malaria research findings, such as these, may play an important role in making available evidence from research in a usable form to policy-makers and practitioners. The study was intended to assist in policy formulation and decision making processes regarding promotions and tenure of researchers, donor funding, areas of research funding, research collaborative activities, etc.

## 1.7 Theoretical Framework

This study used Lotka's Law of Author productivity and Bradford's law of scattering of scientific papers. Lotka's law analyzed citations obtained from publications of malaria in PubMed/Medline. This law states that there are a few researchers who publish a great deal and many who publish very little or nothing at all. The law further observes that: for any body of literature, there will be a substantial number of authors who have each contributed only one

publication, a smaller number of authors who have each contributed a small number of publications, and a very small group of authors who have each contributed a substantial number of publications (Wallace, 1989 and Ikipaahindi, 1985).

According to Rao & Raghavan (2003), and Ikpaahindi (1985), the mathematical demonstration implies that in any given area, the percentage of authors making inputs of one article or publication each out of the total number of publications is 60% (0.60). Ikipaahindi (1985:171), put across the formula thus: "*the productivity of scientists adhered to an inverse square law such that for every 100 authors contributing one article, 25 will contribute two articles, about 11 will contribute 3 articles and 6 will contribute 4 articles*". Diodato (1994: 105), also explains that, "*there is an inverse relation between the number of documents produced and the number of authors producing the documents*".  Lotka's mathematical expression on scientific productivity has been commonly presented as $1:n^2$ where n is the amount of contributions, that is 2, 3, 4 articles that authors have made. As such, if the total number of contributions is 1200 articles, those authors making one contribution each will be 60% of 1200 (or 1920). Those producing two articles each will therefore equal $1/n^2$ of 720 (that is $1/2^2$ of 720 or ¼ of 720), which translates to 420 scientists.

Bradford law of scattering was used to compare the journal distribution in the informetric analysis of malaria research in Zambia under review to establish if the law of the core few applies. Scattering relates to Bradford´s law, which state that, documents on a given subject are distributed according to certain mathematical function so that a growth in papers on a given subject requires a growth in the number of information sources. Bradford´s law states that small core titles of journals have as many papers on a given subject as a much larger number of journals N, which again has as many papers on the subject as N2 journals.

## 1.8    Operational definitions of key Terms

**Citation analysis:** is the examination of the frequency, patterns, and graphs of reference to a published or unpublished in documents. It uses the pattern of citations, links from one document to another document, to reveal properties of the documents. A typical aim would be to identify

the most important documents in a collection. A classic example is that of the citations between academic articles and books (Verma and Thakur, 2010 and Smith, 1981).

**Document type:** Describes the format of an electronic document. Some examples include .doc, .xls, .mdb, .pdf, and .jpeg. Document that accompanies files coded in Standard Generalised Markup Language (SGML) to identify what each markup means and control the structure of the coded files (Wallace, 1989).

**Medline:** is an electronic database created by the National Library of Medicine and offers a wide range of information on subjects such as medicine, nursing, dentistry, veterinary medicine, the health care system, and pre-clinical sciences from over 4600 medical journals (Gupta and Bala, 2010).

**PubMed** is a free search engine accessing primarily the Medline database of references and abstracts on life sciences and biomedical topics (Gupta and Bala, 2010).

**Research Collaboration:** Working collaboratively with colleagues either across University College London (UCL) or other institutions can provide a wide variety of opportunities for research and cross-disciplinary innovation. It also provides the opportunity to reflect upon common accepted norms as these will vary between disciplines, institutions and countries (Wallace, 1989).

**Research output:** is disseminating the findings to an appropriate audience and these can be a paper in a journal, conference paper or presentation, a formal report or a dissertation/thesis for postgraduate study (Verma and Thakur, 2010)

### 1.9    Summary

The chapter had provided a background to the study stressing the importance of journals in research. It also gave the statement of the problem, one general objective and five specific objectives that guided this study and research questions were derived from the specific objectives. The significance of the study was also given. The chapter had set the theoretical framework that guided the study. It further went on to provide the operational definition of key terms and the summary to the study.

# CHAPTER TWO: LITERATURE REVIEW

## 2.1    Overview

This chapter covered the empirical review of studies that have been conducted around the area of Informetric Analysis of Malaria Research. This helped to situate the present study in the right context as gaps in the existing literature were identified. A review of the studies in this area also helped to avoid duplication of any of the past studies. The purpose of undertaking this literature review was to learn from what other researchers have reported on Informetric Analysis of Malaria Research. Gall, Borg, and Gall (1996), states that literature review plays a role in delimiting the research problem, seeking new lines of inquiry, avoiding fruitless approaches, gaining methodological insights, identifying recommendations for further research, as well as seeking support for theories and major concepts in the area of study. The other rationale for conducting a literature review was to get a framework for relating new findings to previous findings in the discussions. Harter (1998), concurs with these sentiments by stating that, without establishing the state of the previous research, it is impossible to establish how the new research advances the previous research.

The sources of information were from different secondary data such as the Internet, articles, books, theses and journals. Therefore, this chapter presents a review on the available literature on malaria and its impacts on the livelihood of the people as discussed by numerous contributors on the subject as defined in the set objectives namely; research output on malaria, organizations conducting research on malaria, authorship collaborations on malaria, core journals in which research on malaria is published, major research areas of malaria.

## 2.2    Research output on malaria

Hussain (2015), in his study whose main objective was a citation analysis of malaria in a study of scientometrics analysis of research output performance of malaria pointed out that during 2003-2007 a total of 15685 papers were published by the scientists in the field of malaria research. The average number of publications produced per year was 20%. The highest number of publications (3731) was produced in 2006. The highest number of publication was at USA and lowest number of publication is at West Indies.

Gupta and Bala (2010), carried out a study on the research output of malaria in India on the national and global context as reflected in its publication output during 1998 – 2009 whose objective was to analyse the research output of India in malaria research. The source of data used was SCOPUS Citation database to retrieve the publication data which was further analysed on several parameters including its growth, rank and global publications share, citation impact, overall share of international collaborative papers and share of major collaborative partners and patterns of research communication in most productive journals. The publications output, impact and collaborative publication share of India were also compared with South Africa, Brazil and China.

The results of the study showed that Indian scientists together had published 2786 papers in malaria research during 1998–2009 and registered an average citation per paper of 3.49. The country ranked 4th among the top 20 most productive countries in malaria research with its global publications share of 6.47% during 1998–2009. The study concluded that Quantum of Indian research output in malaria research was high but its citations per paper was low compared to selected developing countries, which was improved by investing more funds in international and national collaborative research projects, as well as increasing the participation of researchers in such projects

Meena and Nagarajan (2013), conducted a study aimed at evaluating malaria research carried out in different parts of the world during 1974–2013 period using different bibliometrics in growth of Malaria Research Output in Scopus Data Base. Data was downloaded from Scopus database for the period in review using the keywords malaria in the title and abstract fields. The study examined the pattern of growth of the output, its geographical distribution, profile of different countries in different subfields. The USA, followed by the UK and Australia contributed the highest number of papers and the majority of the prolific institutions were located in the USA, the UK, France and Australia. The years that followed witnessed considerable growth in research output in this field, interestingly the countries like the USA, the UK and Australia.

Garg, Dutt and Kumar (2006), aimed at presenting a preliminary scientometric investigation of the research efforts being made worldwide to combat the menace of malaria. The study was on a

preliminary scientometric investigation of malaria research with the analysis of 2275 papers on malaria research published in journals and indexed by the Commonwealth Agricultural Bureaux International (CABI) CD-ROM incorporating Tropical Diseases Bulletin (TDB), and PubMed/Medline Medline (web edition) in 1990 and 2000 indicated that the Science Citation Index (SCI) covered only about 68% of the output indexed by CABI and PubMed/Medline. Malaria research output was highly scattered both in terms of the sub-fields of the journals as well as the publishing country of the journals.

The publication activity in Brazil increased significantly during 2000 as compared to 1990. Most of the prolific institutions were located in the developed countries, particularly in the UK and the USA. 'Parasite biology' constituted the highest output (37%) followed by 'epidemiology'(19%) and 'drug resistance and antimalarials' (16%). USA and Australia emphasized different aspects of 'parasite biology. China and Brazil emphasized different facets of 'epidemiology'. Nigeria and Thailand paid more attention to complicated malaria and its adverse effects' and drug resistance and antimalarials.

Garg et al. (2009), aimed at mapping the quantum of the world output in the field of malaria vaccine research in the study titled Bibliometrics of global malaria vaccine research, which outlined the pattern of publication output in bibliometrics of global malaria vaccine research study from 1972 to 2004. The findings of this study showed that there were a total of 2007 publications scattered over 352 journal titles originating from 40 different countries were published on the topic of malaria vaccine. The pattern of output during the period 1972–2004 was divided in 11 years The number of publications in the first five years was less, which was from1972–1986. An increasing was seen during the later years and reached its peak in the year 1990–1992. There was a slight decline during the periods 1993–1995 and 1996–1998, but later an increase was recorded. During the last year the highest number of publications was seen from 2002–2004.

In the same study of Garg et al (2009), a geographical distribution of research output was conducted in 59 countries that showed 11 countries contributed about 83.5% and 48 countries contributed about 16.5% of the total research papers. The USA, UK and Australia together

contributed more than half of the total publication output. Distribution of the research output for different countries in three years of 11 years each showed that only 12 countries produced 56 papers in the first year (1972–1982), with USA and UK being the main contributors. In the second year (1983–1993), with raising number of countries to 37 and the publication output increased to 663, indicating 12 times that of what it was in the first year. An increase was further seen in the last year (1994–2004), with the number of 50 countries and the 1288 output showing a double output as in the second year.

## 2.3    Organizations conducting research on malaria

A study on institutions/organisations conducting research on malaria was done by Garg et al. (2009), with the aim of mapping the quantum of the world output in the field of malaria vaccine research in the Bibliometrics of global malaria vaccine research from 1972–2004, which came from 420 institutions spread among 59 countries. However, most of these institutions were concentrated in the USA with 117, the UK 44, France 24 and Australia 17. With the remaining 218 institutions spread throughout 55 other countries.

Institutions that contributed 1% or more of the total output had been considered as prolific. A total output, of 21 institutions contributed 908 publications (45%), 8 institutions from the USA contributed 24% of the papers, 4 institutes from the UK contributed 6% of the papers and two institutes each from Australia and Columbia contributed 4% and 3% of publications respectively. The remaining 5 institutions, one each from Sweden, France, India, Switzerland and Papua New Guinea, contributed 8% of publications. There were 21 institutions with their total number of publications, total citations, CPP (citations per paper), NHQ (number of high-quality papers) and RQI (Relative Quality Index).

These impact indicators showed that the value of CPP for 11 institutions were more than average. Five were from the USA, three from the UK and one each from Colombia, Australia and Papua New Guinea and the remaining 10 institutions were less than average. The highest value of CPP was for the John Radcliffe Hospital (UK), followed by the National Institutes of Health (USA) and the Naval Medical Research Institute (USA). All institutions except the

University of Stockholm (Sweden), International Center for Genetic Engineering and Biotechnology (India), London School of Hygiene and Tropical Medicine (UK), F. Hoffmann-La Roche & Co (Switzerland), the University of Maryland (USA), Fundacion Instituto De Inmunologia De Colombia (Colombia) and the University of Hawaii (USA) stood out because of a higher than average incident of high quality papers as the value of the RQI was 1.

In the study on bibliometric analysis of malaria research in India during 1998–2009 by Gupta and Bala (2010), which tabled that the top 30 most productive Indian institutions/organisations involved in malaria research had published more than18 paper during the period under review. These Indian institutions together had contributed 61.05% share (with 1733 papers) in the cumulative publications output of India in malaria research, averaging 56.7 papers per institution. Among the institutions which conducted the research  are: National Institute of Malaria Research, New Delhi with 396 papers, Central Drug Research Institute, Lucknow (with 176 papers), All India Institute of Medical Sciences, New Delhi (with 121 papers), Indian Institute of Science, Bengaluru (with 104 papers), International Centre for Genetic Engineering & Biotechnology, New Delhi (with 99 papers), Vector Control Research Centre, Puducherry (with 91 papers) and Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru (with 81 papers).

The average citations per paper registered by 30 Indian institutions were 3.98. Only 14 Indian institutions have registered higher average citations per paper than the group average. Among these, BHU Institute of Medical Sciences, Varanasi has scored the highest impact of 8.43 citations per paper, followed by Indian Institute of Science, Bengaluru (with 7.86 citations per paper), National Institute of Immunology, New Delhi (with 7.31 citations per paper), National Institute of Pharmaceutical Education & Research, Mohali (with 7.12 citations per paper), Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru (with 7.09 citations per paper), National Centre for Cell Science, Pune (with 6.82 citations per paper), International Centre for Genetic Engineering & Biotechnology, New Delhi (with 5.85 citations per paper), Central Drug Research Institute, Lucknow and Indian Institute of Chemical Technology, Hyderabad (with 5.13 citations per paper).

The average H-index value of these 30 Indian most productive institutions is 9.13. The 12 Indian institutions have scored higher H-index value than the group average. Among them Indian Institute of Science, Bengaluru had scored the highest H-index of 21 for their papers during 1999–2008, followed by Central Drug Research Institute, Lucknow (20), National Institute of Malaria Research, New Delhi (19), International Centre for Genetic Engineering & Biotechnology, New Delhi (14), All India Institute of Medical Sciences, New Delhi (13), National Institute of Immunology, New Delhi (12), Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru (11), Vector Control Research Centre, Puducherry (10), Kem Hospital, Mumbai (10), Jawaharlal Nehru University, New Delhi (10), and National Institute of Pharmaceutical Education & Research, Mohali (10)

Maharana (2014)'s study of Malaria research in India during 2003-2012 a bibliometric analysis aimed to analyze Indian researchers' publications on malaria research and to serve as a guide to libraries needing to collect information on malaria gave a detailed list of major contributing Indian institutions/organizations to malaria research during the period under study, which showed Council for Scientific and Industrial Research (CSIR) with 184 (9.12 percent) documents that stood in the first position. It also showed that contributors affiliated to Department of Biotechnology (DBT) and Indian Council for Medical Research (ICMR) with 132 and 118 contributions were the second and third position. The Contributors from New Delhi and Delhi University with nine contributions had held the eighth position.

## 2.4    Authorship patterns in malaria research

Scientific authorship and collaboration network analysis on malaria research in Benin papers indexed in the web of science (1996–2016) was conducted by Azondekon et al., (2017), whose aim was to document the structure of the malaria collaborative research in Benin. The study analyzed authorship of the scientific documents published on malaria from Benin and collected bibliographic data from the Web of Science on malaria research in Benin from January 1996 to December 2016.

From the collected data, a mulitigraph co-authorship network with authors representing vertices was generated. An edge was drawn between two authors when they co-author a paper. They computed vertex degree, betweenness, closeness, and eigenvectors among others to identify prolific authors. They further assessed the weak points and how information flows in the network. The results showed overall, 427 publications were included in the study. The generated network contained 1792 authors and 116,388 parallel edges which converted in a weighted graph of 1792 vertices and 95,787 edges. Results suggested that prolific authors with higher degrees tend to collaborate more. The hierarchical clustering revealed 23 clusters, seven of which form a giant component containing 94% of all the vertices in the network. This giant component has all the characteristics of a small-world network with a small shortest path distance between pairs of three, a diameter of 10 and a high clustering coefficient of 0.964. However, Monte-Carlo simulations suggested observed network was an unusual type of small-world network. Sixteen vertices were identified as weak articulation points within the network.

It was conclude that the malaria research collaboration network in Benin was a complex network that seems to display the characteristics of a small-world network. The research revealed that the presence of closed research groups where collaborative research likely happened only between members. Interdisciplinary collaboration tends to occur at higher levels between prolific researchers. Continuously supporting, stabilizing the identified key brokers and most productive authors in the Malaria research collaborative network is an urgent need in Benin. It fostered the malaria research network and ensured the promotion of junior scientists in the field.

Hussain (2015), in the study of scientometrics analysis of research output performance of malaria revealed that multi-authorship contribution dominated this field of research. The total output of 15685 between the years 2003-2007, Single authors Rothman, accounted for 1877(11.97%), three authors 1985 contribution accounts for 1638 (10.44%), two 2085(13.29%), four authors 2031(12.95%), five authors 1848(11.78%) and more than five authors 6206(39.47%). The study showed that the contribution of Single and Multi Authored research publication on Malaria was from 2003-2007. It was further revealed that multi-authorship contribution dominates this field of research. From the total output of 15685, Single authors contribution accounts for 1638 (10.44%) and Multiple authored output accounts for 14047 (89.56%).

The total research published output 15686 between 2003-2007 was written by 38942 authors from which the first 200 authors were shown. Author - White N J was the highest contributor on Malaria research publication, whose contribution was 136 records (0.9%), TLCS (Total Local Citation Score) 1244, TGCS (Total Local Citation Score) 1532 and TLCR (Total Global Citation Score) was 530. Author May J was the lowest contributor among the first 200 authors, who had contributed 24 records (0.2%), TLCS 73 (21.07 per year), TGCS 83 (23.05 per year) and TLCR is 112.

Another study conducted by Vijayakumar and Hariharan (2016), examined Malaria research performances during 2010 to 2014 by organising scientometrics analysis of collected data that was downloaded from Web of Science database. The information used for the research included number of papers, author productive, pattern of co-authorship, source journals and also collaboration with different countries. The information was coded and tabulated with the help of various Scientometrics techniques. The results showed that there was a significant growth in quantity of papers from 2010 to 2014. In general, recent papers had averaged more authors, more domestic collaboration, more international collaboration, and more citations received than earlier papers.

## 2.5    Core journals in which research on malaria is published

Maharana (2014), undertook a study on malaria research in India during 2003-2012 a bibliometric analysis. The aim of the study was to analyze Indian researchers' publications on malaria research and to serve as a guide to libraries needing to collect information on malaria. For the purpose of the study Indian researchers' publication data which were indexed in Thomson Reuters Web of Science (WoS) were used. Various statistical techniques and bibliometric measures were employed for further analysis. The study established that 2,020 documents with h-index of 48, published by Indian researchers which were indexed in WoS during 2003 to 2012 and the majority of them were articles (81.43 percent).

Malaria Journal was the most favored research journal among the Indian research community which covered 97 papers. A.P. Dash contributed maximum number of 136 (6.74 percent) papers.

Council for Scientific and Industrial Research (CSIR) was the largest Indian funding agency with 184 (9.11 percent) research grants. Limitation by geographical area and time, that is the study only focused on the research publication of Indian researchers on malaria research during 2003 to 2012. Maharana also stated that it was the first attempt to apply bibliometric techniques to analyze malaria research by Indian researchers, and, more generally for a country which is very badly affected by the disease.

Kolle, Vijayashree and Shankarappa (2016), revealed the bibliometric characteristics of highly cited articles in Malaria research for the period of 1991-2015. A total of 1,614 of highly cited articles were published in the 230 journals for the period of 1991 to 2015, and majority of the articles were appeared in journals that have top impact factor. The articles published in the 2011s have greater average citations and authors per article. Six journals have produced almost a quarter of highly cited articles and remaining articles were published in 224 journals. Proceedings of the National Academy of Sciences of the USA were the most productive journal with 154 articles, which accounts for 9.53 per cent of the total articles, followed by Lancet (110; 6.81 per cent).

They found degree collaboration value of 0.971 for the articles, which indicates the clear dominance of multiple authors in publication of highly cited articles in Malaria research. In this study, new indicator called P index was applied for the evaluation of the author's productivity. As per the p-value, the White, NJ has emerged as the most productive author with the p-value of 0.41 (61 articles), followed by Marsh, K (p _ 0.33), Nosten, F (p _ 0.32) and Snow, RW (p _ 0.31). The USA and the UK were the most productive countries. The article entitled as "Global and regional burden of disease and risk factors, 2001: systematic analysis of population health data" contributed by Lopez et al. (2006) was the most cited article with 2,245 citations in 2015.

Mwendera et al. (2017), conducted a malaria research in Malawi from 1984 to 2016 a literature review and bibliometric analysis. The study showed that there were a total of 118 journals that published malaria research from Malawi with only three (2.5%) African journals, which included the African Journal of Health Sciences with one (0.2%), African Health Sciences with two (0.4%), and the Malawi Medical Journal with 13 (2.7%) publications. However, journals with five (1%) or more publications. It shows that Malaria Journal registered the highest number of

publications, contributing 76 (15.7%) publications, while the local Malawi Medical Journal contributed 13 (2.7%) publications. A total of 483 publications and 165 approved studies were analysed. Clinical and basic research in the fields of malaria in pregnancy 105 (21.5%), severe malaria 97 (20.1%) and vector and/or agent dynamics 69 (14.3%) dominated in the publications while morbidity 33 (20%), severe malaria 28 (17%) and Health Policy and Systems Research 24 (14.5%) dominated in the approved studies.

In the publications, 146 (30%) first authors and 100 (21%) senior authors, and 88 (53.3%) principal investigators in approved studies were affiliated to Malawian-based institutions. Most researchers were affiliated to the Malawi-Liverpool Wellcome Trust, College of Medicine, Blantyre Malaria Project, Ministry of Health, and Malaria Alert Centre. The major malaria research funders were the National Institute for Health/ USA, Wellcome Trust and the US Agency for International Development. Only three (2.5%) out of 118 journals publishing research on malaria in Malawi were from Africa and the Malaria Journal, with 76 (15.7%) publications, published most of the research from Malawi, followed by the American Journal of Tropical Medicine and Hygiene with 57 (11.8%) in comparison to only 13 (2.7%) published in the local Malawi Medical Journal.

Van Eijk et al (2012), undertook a study on the Malaria in Pregnancy Library (MiPL) that was created by the MiP Consortium in 2005 and updated every four months using a standardized search protocol. A bibliometric review was conducted of the contents of the Library to determine dynamics in the type, content and volume of literature on malaria in pregnancy over time. Data on year of publication, type, language, country of first-author affiliation and content were extracted from entries in the MiPL and plotted over time. By January 2012, the MiPL contained 5,346 entries, consisting of 3,721 journal articles (69.6%), 697 reports (13.0%), 219 academic theses (4.1%), 92 books or book chapters (1.7%), 487 conference proceedings (9.1%), 68 registered studies (1.3%) and 62 'other' (1.2%). Most of the sources were in English language (87.3%), followed by French (7.5%) and Spanish (1.5%).

Over 40% of sourced material was publicly available online (42.4%) and the remaining with restricted access (35.0%) or otherwise unavailable (22.7%). The number of journal articles

related to malaria in pregnancy increased from 41 in the 1960s, to 708 in the 1990s, and 1,895 between 2000 and 2009, and the variety of themes has increased over time. English-language articles were sourced from 737 different journals. The top three journals were the American Journal of Tropical Medicine and Hygiene (184), Malaria Journal (158) and the Transactions of the Royal Society of Tropical Medicine and Hygiene (131). It was concluded that the last decade had seen a dramatic increase in publications related to malaria in pregnancy, and an increasing proportion of these are publically available online. The MiPL was a useful, scholarly source for literature and systematic reviews related to malaria in pregnancy which showed on how the prevention and control were achieved.

## 2.6    Major research areas of malaria

A study was conducted by Fu et al (2015), on bibliometric analysis of malaria research in China during 2004–2014. The study showed how China had made great progress in malaria prevention and control, even though there had been no research to provide a macroscopic overview of malaria research in China. The bibliometric analysis was conducted from international databases to explore the characteristics of malaria investigations in China. The source of data used was on Published scientific papers about malaria were retrieved from China National Knowledge Infrastructure (CNKI), Wanfang database and PubMed/Medline during 2004–2014. Year of publication, first-author affiliation, journal name and keywords were extracted with the Bibliographic Items Co-occurrence Matrix Builder (BICOMB).

High-frequency keywords were selected to construct the co-word matrix and divided into eight categories. Sub-networks were utilized to analyse the complex knowledge structures. The results in recent ten years showed that a total of 5,126 entries were included. The number of papers on malaria started to increase since 2010. The papers published by top 12 Chinese journals in the field of malaria accounted for 32.98% in overall articles. Most of the studies were conducted by the researchers from the Centers for Disease Control and Prevention (CDCs). The words "malaria", "imported malaria", "falciparum malaria", "vivax malaria" and "malaria surveillance" were the centers of knowledge structures. In conclusion Chinese studied on malaria mainly focused on the epidemiology and biomedical fields; the study offered a systematic evaluation on the output of malaria studies and the elimination of malaria in China.

The prevention and control study was done by Waleed et al. (2017), study on was carried out on the Bibliometric Analysis of Worldwide Publications on Antimalarial Drug Resistance from 2006–2015. The study was in response to international efforts to control and eradicate malaria and designed to give a bibliometric overview of research productivity in antimalarial drug resistance (AMDR). A total of 976 publications with an h-index of 63 were retrieved from the Scopus database with a noticeable increase starting in the early 1990s.TheUSA was the most productive country with 337 publications equivalent to one-third of worldwide publications in this field.

More than two-thirds of publications by the USA (236, 70.03%) were made by international collaboration. Of the top ten productive countries, two countries were from Mekong sub-region, particularly Thailand and Cambodia. The Malaria Journal was the most productive journal (136, 13.93%) in this field. Mahidol University (80, 8.20%) in Thailand was the most productive institution. Seven articles in the top-ten list were about artemisinin resistance in Plasmodium falciparum, one was about chloroquine resistance, one was about sulfadoxine-pyrimethamine resistance, and the remaining one was about general multidrug resistance. Eradication and control of AMDR require continuing research activity to help international health organizations identify spots that require an immediate action to implement appropriate measures.

Garg et al. (2009), undertook a study that evaluated malaria vaccine research carried out in different parts of the world during 1972–2004 using different bibliometric indicators. The data was downloaded from PubMed/Medline for the period 1972–2004 using the keywords malaria and vaccine in the title and abstract fields. The study examined the pattern of growth of the output, its geographical distribution, profile of different countries in different subfields and pattern of citations using Google Scholar and the malaria vaccine research output was gradually increasing. The USA, followed by the UK and Australia contributed the highest number of papers. Publication activity had decreased in Switzerland and Sweden, but had increased in Brazil and China.

The majority of the countries focused on the development of asexual blood stage malaria. Citations per paper and incidence of high-quality papers for the USA, the UK, Papua New

Guinea and Denmark are more than the average. The majority of the prolific institutions were located in the USA, the UK, France and Australia. It was concluded that the last two decades had witnessed considerable growth in research output in this field, while a successful malaria vaccine still remained elusive. Interestingly, the countries like the USA, the UK and Australia that lead in the quantity, quality and citation of this output are often not those directly affected by malaria.

Sweileh (2016), carried out a study on emergence of insecticide resistance in malaria vectors was a real threat to future goals of elimination and control of malaria with the objective assess research trend on insecticide resistance of Anopheles mosquito. In specific, number of publications, countries, institutions, and authors' research profile, citation analysis, international collaborations, and impact of journals publishing documents on insecticide resistance were presented. It was conducted through Scopus search engine which was used to retrieve relevant data. The duration of study was set from 1996–2015. A total of 616 documents, mainly as original research articles (n = 569; 92.37%) were retrieved.

The average number of citations per article was 26.36. Poisson log-linear regression analysis indicated that there was a 6.00% increase in the number of publications for each extra article on pyrethroid resistance. A total of 82 different countries and 1922 authors participated in publishing retrieved articles. The United Kingdom (UK) ranked first in number of publications followed by the United States of America (USA) and France. The top ten productive countries included seven African countries. The UK had collaborations mostly with Benin (relative link strength = 46). A total of 1817 institution/ organizations participated in the publication of retrieved articles.

The most active institution/ organization were Liverpool School of Tropical Medicine. Retrieved articles were published in 134 different scientific peer reviewed journals. The journal that published most on this topic was Malaria Journal (n = 101; 16.4%). Four of the top active authors were from South Africa and two were from the UK. Three of the top ten cited articles were published in Insect Molecular Biology journal. Six articles were about pyrethroid resistance and at least two were about Dichloro-Diphenyl-Trichloroethane (DDT) resistance. Publications on insecticide resistance in malaria vector had gained momentum in the past decade.

International collaborations enhanced the knowledge about the situation of vector resistance in countries with endemic malaria. Molecular biology of insecticide resistance was the key issue in understanding and overcoming the emerging problem.

## 2.7    Summary

This chapter has reviewed literature relevant to the study´s theme. Indicating the purpose for reviewing, the importance of resource usage evaluation and has pointed out some researches formerly conducted and their methodologies. The chapter further outlined and discussed researches that have used citation analysis of journals, pointing out the reasons behind undertaking such studies. Therefore, this study contributes to the understanding of the informetric analysis of malaria research in Zambia.

# CHAPTER THREE: METHODOLOGY

## 3.1    Overview

This chapter described the research method that was used in carrying out the research. The chapter was divided into the following sections: research design, population of the study, sample size and sampling procedures, research instruments data collection techniques, and data analysis.

## 3.2    Research design

According to Sealse (2012), research design is the collection of decision about methods and methodology that a researcher must make when setting out to do a research study. Gray (2009), defines research design as the overarching plan for collection, measurement and analysis of data while Thomas (2013), simplified it as just a plan for the research. The design of research depends on the most appropriate methodological approach pertinent to the topic or question. Typically, it describes the purpose of the study and the kinds of questions being addressed, the techniques used for data collection, approaches to selection of samples and how the data are going to be analysed.

This study adopted an informetric approach to quantitative aspects of information which includes the production, dissemination and use of all forms of information regardless of its form or origin; be it scientometrics, webometrics, cybermetrics and bibliometrics. Therefore, during the retrieval of information, the term "malaria" was used as topic/subject and "Zambia" was used as authors' address/affiliation, (Nacke, 1979).

## 3.3    Population of the study

Gray (2009), defines the sample size as a set of objects, occurrences or individuals selected from a parent population for the research study. The study's population was drawn from publications on malaria in Zambia as indexed and reflected in one key bibliographic database which is PubMed/Medline. The target populations therefore were all those documents published on malaria in Zambia from 1961 to 2016 as reflected in the PubMed/Medline databases. The papers focused on malaria research in Zambia. The study had 440 research publications on malaria in Zambia in PubMed/Medline and was retrieved using the search terms Malaria AND Zambia. The

results were refined by the use of the Boolean operator "AND". Engines designed to search Medline such as Entrez and PubMed generally use a Boolean expression combining MeSH terms.

PubMed is a free search engine accessing primarily the Medline database of references and abstracts on life sciences and biomedical topics. PubMed/Medline bibliographic database was earmarked for data collection. PubMed/Medline was chosen in preference to others because it has a wider and current coverage and it contains over 25 million records on different topics in the field of medical database and non medical citations. It has easy keyword searching and automatic mapping to MeSH terms and it also offers related citations and links to systematic reviews citing a study.

## 3.4    Data collection techniques
The retrieved publications were grouped according to place of publication, date of publication, title, author(s), publishers, type of document (journal, conference papers, books, and technical reports), number of authors, keywords, and subject matters such as malaria, citation analysis and Zambia.

## 3.5    Data Analysis
The malaria research bibliographical material in the all sampled publications were electronically extracted and classified into eight (8) exclusive formats; books, journals, web resources, manuscripts, theses, conference papers, newspapers and other resources (comprising of magazines newsletter). These were coded and the codes later entered into SPSS 23.0 software where the researcher analysed the data by using the descriptive statistics were frequency tables and the bar charts were generated.  Data citations were then statistically analysed and tabulated using SPSS 23.0 and MS Excel 2007 packages to establish research output on malaria in Zambia; organizations conducting research on malaria in Zambia; authorship collaborations on malaria in Zambia; core Journals in which research on malaria is published and major research areas of malaria in Zambia including the bibliographical materials in Zambia were entered into MS Excel spreadsheet for analysis.

## 3.6    Limitation of the study

The findings of the research methodologies did not capture all the studies that are done in Zambia. This study was limited to PubMed/Medline, which made the findings limited because other online databases were not used such as Scopus, Web of knowledge and Google scholar which could also given data on informetrics analysis of malaria. In such an instant the results were not generalised but restricted.

## 3.7    Summary

This chapter dealt with the research approaches employed to conduct the study on the patterns of production and distribution of malaria literature in Zambia, aiming to assess the trends and patterns of research on malaria in Zambia. The quantitative approach was used when designing and planning this study. The study made use of informetric approaches, which is citations analysis, to fulfill its general objectives. This chapter also outlined the approaches that were used to analyze, present and interpret the data, as well as the problems that were encountered before, during and after data collection.

## CHAPTER FOUR: FINDINGS

## 4.1 Overview

This chapter presents the findings of the study. The main objective of this study was to investigate the research output on malaria in Zambia. The specific objectives were: to investigate the research output on malaria in Zambia in PubMed/Medline, to identify the organisations conducting research on malaria in Zambia, to explore authorship patterns in malaria research, to identify the core journals in which research on malaria is published, and to identify the major research areas on malaria in Zambia,

## 4.2 Research Output on Malaria

The numbers of research papers retrieved from PubMed/Medline were 440. These publications were grouped in 5 year bands from 1961 to May 2016. The findings are shown in Table 1 and Figure 1. Findings shown in Table 1 reveal that early publications on malaria were infrequent with the lowest 0.5% (2) publications recorded during the period 1971 to 1975. From 1961 to 1975 there was a downward trend in the research output on malaria in Zambia being 1.1% (5) to 0.5% (2). However, from 1976 the number of publications was progressively increasing with the highest being in the period 2011 to May 2016 with 45.2% (199) publications. This reveals that the number of publications on malaria was highest in the period of 2011-2016. The increased trend in publications on malaria significantly began from 1966- 2001 period.

*Table 1: Zambia's research output on malaria, 1961-2016*

| Period | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| 1961-1965 | 5 | 1.1 | 1.1 |
| 1966-1970 | 3 | .7 | 1.8 |
| 1971-1975 | 2 | .5 | 2.3 |
| 1976-1980 | 16 | 3.6 | 5.9 |
| 1981-1985 | 16 | 3.6 | 9.5 |
| 1986-1990 | 29 | 6.6 | 16.1 |
| 1991-1995 | 25 | 5.7 | 21.8 |
| 1996-2000 | 33 | 7.5 | 29.3 |
| 2001-2005 | 36 | 8.2 | 37.5 |
| 2006-201 0 | 76 | 17.3 | 54.8 |
| 2011-2016 | 199 | 45.2 | 100.0 |
| **Total** | **440** | **100.0** | |
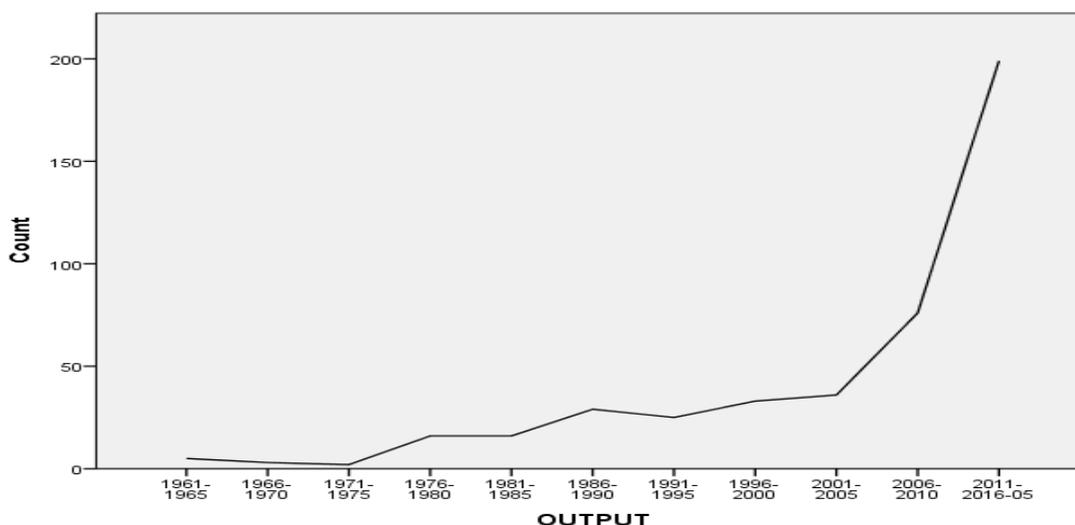
*Figure 1: Zambia's research output on malaria, 1961-2016*

## 4.3    Organizations Conducting Research on Malaria

On organisations conducting research on malaria in Zambia, the findings are shown in Table 2. The finding indicates that there were mainly five types of organizations that had conducted research and publications on malaria in Zambia. It further indicates that, the Research Medical Institutions such as National Institute for Health Research Biomedical Research centre, Institute of Molecular Biology & Biotechnology, National Institute of Health Research and Biomedical Research & Training Institute had the majority share of malaria research publications at 41.6% (183) followed by the Non-medical Institutions were Theta Epsilon, Abt Associates, Zambia Consolidated Copper Mines and Academy for Educational Development at 19. 3% (85), the Zambian Local Research Organisations, these are Tropical Diseases Research Centre, Macha Malaria Research Institute, National Malaria Control Centre and Centre for Infectious Disease Research at 19.1 % (84), International Organizations namely centre for Global Health and Development, Department of International Health and  at 17.3% (76) while Government of the Republic of Zambia like Ministry of Health, Chainama Hospital, Ndola Central Hospital, malaria research publications were at   2.7%(12). These findings reveal that research on malaria was mainly conducted by Medical Research Institutions as indicated by publications at 41.6% (183).

*Table 2: Types of organization conducting research on malaria in Zambia*

| Type of Organisations | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| Medical Research Institutions | 183 | 41.6 | 41.6 |
| Non-Medical Institutions | 85 | 19.3 | 60.9 |
| Zambian Local Research Organisation | 84 | 19.1 | 80.0 |
| International Organisation | 76 | 17.3 | 97.3 |
| Government Republic of Zambia | 12 | 2.7 | **100.0** |
| **Total** | **440** | **100.0** | |

## 4.4    Authorship patterns in Malaria Research

The researcher sought to establish the author patterns in Malaria research, Findings on the same are shown in Table 3. Table 3 shows that of the publications on Malaria journal and citations sampled, the author collaboration distribution patterns on articles on Malaria were that 54.5% (240) of the publications were coauthored by groups of more than five people, followed by single authorship pattern at 16.2% (71), while the two authorship collaboration pattern was at 10.7% (47), three authorship collaboration pattern was at 10%(44) and four authorship collaboration pattern was at 8.6 %(38) of the published articles on malaria. In general, authorship collaboration pattern of published articles on malaria in Zambia was dominated by the more than 5 authorship collaboration pattern, while the 4 authorship collaboration pattern was lowest. This shows that generally the number of co-authorship patterns on Malaria research publication ranged from one to five, with the 5 or more authorship collaboration pattern being the highest.

*Table 3:  Authorship patterns in Malaria Research*

| Number of Authors | Frequency | Percent | Cumulative Percent |
|---|---|---|---|
| 5+ authors | 240 | 54.5 | 54.5 |
| single author | 71 | 16.2 | 70.6 |
| 2 authors | 47 | 10.7 | 81.3 |
| 3 authors | 44 | 10.0 | 91.3 |
| 4 authors | 38 | 8.6 | **100** |
| **Total** | **440** | **100.0** | |

On the other hand, Table 4 shows findings on the authorship pattern trends on Malaria, in the five years bands from 1961 to 2016 period. The said Table shows that out of 440 publications retrieved from the PubMed/Medline, in the category of multi-authorship trends, findings indicate that the highest multi authorship malaria publications trend was in the period 2011-2016 with 51.8% (191) followed by the 2006-2010 period at 12.7%(67) and the lowest was during the period 1961-1965 with 0.3% (1) while trends in the category of single authorship malaria publications, the findings indicated that the highest number of single authorship was in the period 1976-1980 with 14.1%(10) of the publications, followed by the 2006-2010 with 12.7%(9) and the lowest was during the period 1966-1970 8.4%(1) . This brought to light that the period from 2011-2016 was the core of malaria research publications over a 56-year period in Zambia. The major trend of the mentioned period was Multiple Authorship publications. Further analysis of the data in Table 4 indicates that the period 1976-1980 would be ranked second in both authorship trends though the quantitative values for Single-Authorship trend 12.7%(9) and Multiple-Authorship trend 18.2%(67) are different.

*Table 4: Authorship pattern Trends by 5 year Periods from 1961 to 2016*

| Period | Authorship patterns Trends | | | | Gross Total | CC |
| | Single Authorship | | Multi Authorship | | | |
| | Frequency | Percentage | Frequency | Percentage | | |
|---|---|---|---|---|---|---|
| 1961-1965 | 4 | 5.6 | 1 | 0.3 | 5 | 0.2 |
| 1966-1970 | 1 | 1.4 | 2 | 0.5 | 3 | 0.6 |
| 1971-1975 | 2 | 2.8 | 0 | 0.0 | 2 | 0 |
| 1976-1980 | 10 | 14.1 | 6 | 1.6 | 16 | 0.4 |
| 1981-1985 | 7 | 9.9 | 9 | 2.4 | 16 | 0.6 |
| 1986-1990 | 8 | 11.3 | 21 | 5.7 | 29 | 0.7 |
| 1991-1995 | 6 | 8.5 | 19 | 5.1 | 25 | 0.8 |
| 1996-2000 | 8 | 11.3 | 25 | 6.8 | 33 | 0.8 |
| 2001-2005 | 8 | 11.3 | 28 | 7.6 | 36 | 0.8 |
| 2006-2010 | 9 | 12.7 | 67 | 18.2 | 76 | 0.9 |
| 2011-05/2016 | 8 | 11.3 | 191 | 51.8 | 199 | 0.9 |
| **Total** | **71** | **100** | **369** | **100** | **440** | **0.8** |

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**4.5      Core Journals in which Research on Malaria is published**

The findings on core journals in which research on malaria was published, are shown in Table 5. Table 5 shows that of the 440 publications retrieved from PubMed/Medline, there were 16 journals contributed 60.2% (265) of the publications. This disclosed that there were 16 core journals were malaria research articles were published. The journal with highest number of malaria publications was the Malaria Journal with a frequency of 101 (23.0%) followed by the American Journal of Tropical Medicine and Hygiene with a frequency of 34 (7.7%); Tropical Medicine International Health Journal with a frequency of 34 (6.1%); while the PLoS One Journal and the Transaction of the Royal Society of Tropical Medicine Hygiene Journal both had the same frequency of 15 (3.4%). While the Medical  Journal of Zambia had a frequency of 12 ( 2.7%); Central  African  Journal of  Medicine with a frequency of 10 (2.3%);  the Parasites and Vectors Journal with a frequency of 7 (1.6%), East African Medical Journal, Journal of Infectious Diseases, Journal of Tropical Medicine and Hygiene, Tropical and Geographical Medicine Journal all shared the frequency of 6 (1.4%). The lowest considered Journals were the Annals of Tropical Medicine and the Parasitology journal, the Bulletin of the World Health Organization, the Lancet and Tropical Doctor Journals each with a frequency of 5 (1.1%). Others journals had a frequency of 175(39.8%) of the publications on Malaria. This entails that the Malaria Journal was the most considered journal for publication of research articles on malaria with a frequency of 101(23.0%)

*Table 5: Core Journals in which Research on Malaria is published*

| SN | Name of Journal | Frequency | Percent | Cumulative Percent |
|---|---|---|---|---|
| 1 | Malaria Journal | 101 | 23.0 | 23.0 |
| 2 | American Journal of Tropical Medicine and Hygiene | 34 | 7.7 | 30.7 |
| 3 | Tropical Medicine International Health | 27 | 6.1 | 36.8 |
| 4 | PLoS One | 15 | 3.4 | 40.2 |
| 5 | Transaction of the Royal Society of Tropical Medicine Hygiene | 15 | 3.4 | 43.6 |
| 6 | Medical Journal of Zambia | 12 | 2.7 | 46.4 |
| 7 | Central African Journal Medicine | 10 | 2.3 | 48.6 |
| 8 | Parasites and Vectors | 7 | 1.6 | 50.2 |
| 9 | East African Medical Journal | 6 | 1.4 | 51.6 |
| 10 | Journal of Infectious Diseases | 6 | 1.4 | 53.0 |
| 11 | Journal Tropical Medicine and Hygiene | 6 | 1.4 | 54.3 |
| 12 | Tropical and Geographical Medicine | 6 | 1.4 | 55.7 |
| 13 | Annals of Tropical Medicine and Parasitology | 5 | 1.1 | 56.8 |
| 14 | Bulletin of the World Health Organization | 5 | 1.1 | 58.0 |
| 15 | Lancet (London, England) | 5 | 1.1 | 59.1 |
| 16 | Tropical Doctor | 5 | 1.1 | 60.2 |
| 17 | Others | 175 | 39.8 | 100 |
| | **Total** | **440** | **100** | |

## 4.6    Major Research Areas on Malaria

The researcher sampled the published articles malaria to find out the major Malaria research areas. The findings are shown in Figure 2. Figure 2 shows that a significant number of authors 54.3% (239) authored on unspecified aspects, that is general aspects on malaria, while 18.4% (81) authors focused on the treatment of malaria; 3.9% (17) of the authors concentrated on the diagnosis of malaria; further, 15% (66) of the authors focused on the prevention of malaria and 23(5.2%) focused on diagnosis and treatment of malaria, while 2.7%(12) of the authors focused on the causes of malaria and the minority 0.5%(2) focused on the symptoms of malaria. These findings entail that the majority 54.3% (239) of the authors and researchers on malaria focused on general aspects of malaria.
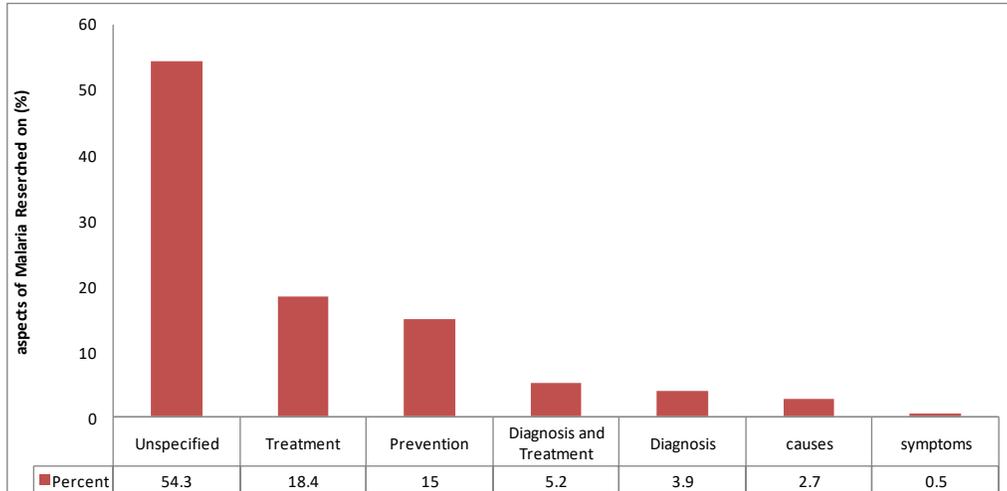
*Figure 2: Research Areas on Malaria in Zambia*

## 4.7    Summary

This study analyzed citations obtained from 440 publications of malaria in Zambia in PubMed/Medline. The findings revealed that the number of publications output on malaria in Zambia was highest in the period 2011 to 2016 with the percentage of 45.2 (199) publications, whilst the lowest being from the period 1961 to 1975 with the percentage of 5 (2).   On organisations conducting research on malaria in Zambia, Medical Research Institutions had the majority share of malaria research publications at 41.6% (183) while Government of the Republic of Zambia like Ministry of Health, Chainama Hospital, Ndola Central Hospital malaria research publications were at  2.7%(12).

The authorship collaboration distribution patterns on articles on malaria showed that 54.5% (240) were coauthored by groups of more than five people, with the lowest of  four authorship collaboration pattern was at 8.6 %(38) of the published articles on malaria. Furthermore on core journals in which research on malaria was published, it was discovered that of the 440 publications retrieved from PubMed/Medline, 16 journals contributed 60.2% (265) of the Journals. The distribution of the research publications on aspects of malaria indicated that a significant number of authors 54.3% (239) authored on general and unspecified aspects on malaria, while the lowest 0.5% (2) focused on the symptoms of malaria

**CHAPTER FIVE: DISCUSSIONS OF FINDINGS**

## 5.1 Overview

This chapter discusses the findings of the study whose main objective was to investigate research output of malaria in Zambia. The findings of the study are discussed thematically with reference to the specific objectives of the study which were: to investigate the research output on malaria in Zambia in PubMed/Medline, to identify the organisations conducting research on malaria in Zambia, to explore authorship collaboration in malaria research, to identify the core Journal in which research on malaria is published and to assess the major research areas on malaria in Zambia. The methodology of the study employed an informetric analysis of malaria research publications in Zambia. Informetric analysis provides a researcher with a basis for making generalizations on publications of the phenomena under study. The study revealed a number of significant findings in relation to the objectives set out indicated in chapter one. This chapter highlights critical grounds for drawing study conclusions and recommendations.

## 5.2 Research output on Malaria

The findings revealed that malaria research publications in Zambia retrieved from the PubMed/Medline were grouped in 5 year bands from 1961 to 2016 covering 55 years from late pre-independence era to post Independence era. The findings on research output publications on malaria in Zambia during the pre-independence era were very low. These results are expected because during a pre-independence and early post-independence era, there were very few research institutions. This entails that of the research out publications that accounted for malaria research in Zambia were also correspondingly very low. The other factor that can be attributed to very low research out publications on malaria in the pre-independence and early post–independence era is that there few medical infrastructures and extremely very few qualified experts to engage in research.

Due to few medical infrastructures and very few qualified experts to engage in research there was a relatively low research output publication on malaria.  However, the analysis of the publications trends on Malaria, for a period of 41years from 1976 to 2017, retrieved from PubMed/Medline indicate  that there was a progressive increase in research publications on Malaria in Zambia. The highest number of publication on malaria was recorded in the post-

Independence era 2011 to 2016. Despite the increase in publications in the 41year period, the study further reveals that there was a reduction in malaria publications in the period from 1971-1995, from 1966-1970, a reduction was further seen.

This reduction however is counteracted by a significant sharp increase as observed in the period from 2011-2016. It can be concluded that there has been a significant improvement in output of malaria publications in Zambia over a period of 35 years beginning from 1976 to 2011. This increase could be attributed to several factors. One of the factors could be the increased development and establishment of medical facilities in Zambia. This finding corresponds to observations in the national reports on health that indicate that soon after independence, Zambia had few doctors and few health facilities (MOH 2010). The same study observed that after independence Zambia embarked on constructing health facilities with the construction of provincial and district hospitals. This explains the relative increase in Malaria research in Zambia. When there is an increase in the development and establishment of health facilities entails that there are an increase in facilities that potentially could be used for research. Zambia being in the tropics entails the focus of research would be tropical diseases of which malaria is the major menace. The other factor contributing to increased malaria research output could be the increased number of Medical Doctors graduated from the University of Zambia and began practicing medicine during this period, (MOH 2010 and NMCC/CBOH, 2000). The increase in the number of Medical Doctors graduation and practicing medicine can also account for a relative increase in research on tropical diseases of which malaria is one of them. Research could be as part of their study requirements or part of their continuing Professional development in their career development from junior doctors through Senior Doctors to specialist doctors and professors in medicine.

The finding of this study was in line with Garg et al. (2009), who focused on mapping the quantum of the world output in the field of malaria vaccine research study on the Bibliometrics of global malaria vaccine research, which like the findings in this study sketched out the pattern of publication output from 1972 to 2004. The analysis of the Garg quantum mapping of malaria research output shows similar trend observed in this study, that the output started on a very low note then there was an increase, a reduction, then a significant increase.

A study on research output on malaria by Garg, Dutt and Kumar (2006) showed contrary findings to the findings to this study.  The study, a preliminary scientometric investigation of malaria research with the analysis of 2,275 papers on malaria research published in journals and indexed by Commonwealth Agricultural Bureaux International (CABI) CD-ROM incorporating Tropical Diseases Bulletin (TDB), and PubMed/Medline Medline (web edition) in 1990 and 2000 indicated that the Science Citation Index (SCI) covered only about 68% of the malaria output indexed by CABI and PubMed/Medline. It further showed some contrast in that malaria research output was highly scattered both in terms of the sub-fields of the journals as well as the publishing country of the journals, which was not found in the findings of this research. In the sub-fields of research on Malaria output publication covered malaria; 'Parasite biology' constitutes the highest output and 'drug resistance and antimalarials' showing the lowest.

The contrast of the Garg, Dutt and Kumar(2006), study findings to the findings of this would be attributed to observations  that Garg, Dutt and Kumar Study was predominantly focused on developed countries were research and publication were much advance than the Zambian situation where this study focused. It must be noted therefore the contrast of the Garg, Dutt and Kumar study did not nullify the findings of this study.

## 5. 3    Organizations Conducting Research

The findings on the number of organizations conducting research on malaria in Zambia in the past forty five years revealed that organizations such as the Medical Research Institutions on malaria contributed highest of the 440 malaria publication surveyed from the PubMed/Medline with Government Republic of Zambia showing the lowest.  It can be concluded that majority of the research publication on malaria were done by the Medical Research Institutions whereas the Government of Zambia ministries had the least number of malaria research publication. These findings seem to highlight the contrast that despite Zambia launching the 2030 roll-back malaria project (WHO, 2010 and USAID, 2014), there was no significant corresponding increase in Government publications on Malaria. This can be attributed to fact that most projects and activities pertaining to malaria were donor funded as such most research projects were published in other journals other than Zambian and Government publications.

This may also mean that PubMed/Medline may not be publishing Zambian government reports and Zambian publications on malaria research. If the government was to put more efforts and resources on the research on malaria, the 2030 roll-back malaria project could easily be attained and there would be more malaria publications in the Government and local Journals can be observed and deduced from the findings of this study that several researches on malaria in Zambia have been conducted and are still being conducted by several organizations. Among the organizations conducting researches on malaria in Zambia are Government organizations themselves, Zambian Local Research Organizations, International Organisations, Medical Research Institutions and Non-medical institutions. The findings of this revealed that Medical Research Institutions were leading institutions in research publication on malaria.

Similarly a global study on institutions or organisations conducting research on malaria by Garg et al. (2009), agrees with the findings of this study in that the leading institutions or organisations on malaria research publications were international organisations with a high concentration in the USA and lower concentration in Australia. The impact indicators showed that the value of CPP was higher in the USA and lower in the Papua New. An analysis of these findings seems to validate results of this study in that most research output on malaria in Zambia was lead by International Medical Institutions.

The findings of the study are also in line with another study by Gupta and Bala (2010), on bibliometric analysis of malaria research in India during 1998–2009 were it was discovered that the top 30 most productive Indian institutions or organisations involved in malaria research had published more than 18 and above during the period in review agreeing to the findings of this study. These institutions contributed highest share in the cumulative publications output of India in malaria research. Some of the institutions which conducted the research were National Institute of Malaria Research, New Delhi with 396 papers, Central Drug Research Institute, Lucknow (with 176 papers), All India Institute of Medical Sciences, New Delhi (with 121 papers), Indian Institute of Science, Bengaluru (with 104 papers), International Centre for Genetic Engineering & Biotechnology, New Delhi (with 99 papers), Vector Control Research Centre, Puducherry (with 91 papers) and Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru (with 81 papers). Only 14 Indian institutions had registered higher average

citations per paper than the group average showing that international institution/organisations has written more research journals in bibliometric/informetric in malaria research than the local Zambian institutions. The Gupta and Bala (2010) gave a similar perspective to this Zambian study, that the leading Institutions on malaria research output publications were international in nature and that there was low malaria research output publications from Government related organisations in both Indian and Zambian context.

## 5. 4    Authorship patterns in Malaria Research

The findings on authorship patterns on malaria research in Zambia, the researcher found that generally the number of co-authors on the incidences of malaria ranged from one to five. Lotka's law of author productivity states that for any body of literature, there will be a substantial number of authors who have each contributed only one publication, a smaller number of authors who have each contributed a small number of publications, and a very small group of authors who have each contributed a substantial number of publications in line with the findings of this study which reviewed that about the highest publications sampled were co-authored by groups of more than five people, while single authored recorded the lowest.

It can be concluded that there few works on Malaria in medicine done by single authored. Further the analysis of publications shows that the trend on the distribution of authors on Malaria Research publications in 1961 to 1975 was dominated by works of single authors compared to multiple authors. However it can be observed that the number of multiple authored works increased from 1985 to 2016. This trend may be attributed to several factors such as the increased number of facilities dealing with malaria during the stated period. At independence in 1964, the numbers of medical facilities were estimated at 16 while by 2016 the medical facilities were estimated to be at 1,882 (MOH, 2010) which indicates an increase compared to 1964 period. The Authorship pattern of multiple authors can be attributed the increase of research projects were multiple authors was preferred by many donors and sponsors of the malaria projects

Furthermore, analysis was conducted to establish the degree of collaboration (collaboration coefficient) among the authors using Lotka's formula which is calculated by the number of multiple authorship publication over total number of single authored publication such as 1/5=

0.2. The closer it is to one the higher the collaboration. From 1981 to 2016 one can see a steady increase with the maximum of 0.9, which meant that most works have been multiple authorships with a decline in single authorship. So, we can deduce that there has been more of author collaboration particularly done by more than five authors. This is a good practice as the more authors are involved in collaborative research; the higher the prospects are for objectivity, validity, reliability of the findings of the research, where by protecting the Public Health from biased and inaccurate information.

This study established that generally the number of co-authors on the incidences of malaria had a larger percentage. This is also in line with a research on scientific authorship and collaboration network analysis on malaria research papers in Europe.  In Benin, Azondekon et al., (2017), conducted a study, indexed in the web of science (1996–2016). The aim of the study was to document the structure of the malaria collaborative research in Benin. The study analyzed authorship of the scientific documents published on malaria from Benin and collected bibliographic data from the Web of Science on malaria research in Benin from January 1996 to December 2016. From the collected data, a mulitigraph co-authorship network with authors representing vertices was generated. An edge was drawn between two authors when they co-author a paper. They computed vertex degree, betweenness, closeness, and eigenvectors among others to identify prolific authors. Results suggested that prolific authors with higher degrees collaborated more. It was concluded that the research revealed the presence of closed research groups where collaborative research happened only between members, interdisciplinary collaboration occurred showing the same trend as in the findings of this research. Productive authors in the malaria research collaborative network were also seen in Benin when it fostered the malaria research network and ensured the promotion of junior scientists in the field. The study by Azondekon et al., (2017), though a European perspective agrees with the findings of this study Zambian study that there were more collaborative authorship on Malaria studies than single authorship.

The finding of this study on multi-authorship are also in line with a study conducted research by Hussain (2015), on scientometrics analysis of research output performance of malaria revealed that multi-authorship contribution dominated this field of research. The total output of 15,685 between the years 2003-2007, Single authored accounted for less, whereas co-authored

accounted for more. The study showed that the contribution of Single and Multi authored research publication on Malaria from 2003-2007 was similar to the findings of this research.

In line with the researcher's findings a similar study was done by Russian researchers, Vijayakumar and Hariharan (2016). In their study examined Malaria research performances during the period of 2010 to 2014 by conducting Scientometrics analysis of collected data downloaded from Web of Science database. The study showed that the author productive, pattern of co-authorship, source journals and also collaboration with different countries. The results showed that there was a significant growth in quantity of papers from 2010 to 2014 and had averaged more authors, more domestic collaboration, more international collaboration, and more citations received than earlier papers.

## 5.5    Core Journals in which Research on Malaria is published

This study has revealed that of the 440 publications retrieved in PubMed/Medline, there are 16 core journal publications where research on malaria in Zambia has been published. In Library and Information Science (LIS), research on literature scattering has been conducted. Scattering in librarianship refers to Bradford´s law which state that small core journals have as many articles on a given subject as a larger number of journals have. Based on the core journal distribution shown in table 5. The Malaria Journal had the highest publications, while the lowest numbers of malaria publications were the Annals of Tropical Medicine Journal, the Parasitology Journal.

The distribution of the Journal of the 440 publications retrieved in PubMed/Medline when analysed further indicates that of the top leading journals majority of the publications were done in International Journals only three (3) journals were published in Zambia. It also indicates that there were more publications done on other continents than Africa.  In Africa publications came from the Central African and East African regions. It can be concluded that there is a high preference for Foreign and International journals when it comes to publishing research on Malaria in Zambia. This preference could be attributing to several factors. One of the factors is that international journals are perceived to have a large and wider readership cliental. Another factor could be that most of the international Journals have a higher academic rating therefore; authors and researchers tend to view the publication of their articles in renowned journals as a credit to their academic acumen.  It tends to raise their status as writers, researchers and experts

or specialists in their fields were they have published several articles. In the world of academia, studies at Masters' and Doctorate levels require a thesis and several other publications for one to graduate as such International reputable journal are sort for publication of their articles. This accounts for the reason why there is a high preference for International Journals.

Similarly, Mwendera et al. (2017), conducted a Malaria research in Malawi from 1984 to 2016 a literature review and bibliometric analysis, were a total of 118 journals that published malaria research from Malawi. The findings of this study showed the same trend as that of the researchers finding because even in this study very few local journals were found to be conducting research in bibliometrics and informetrics on malaria.

Another researcher Van Eijk et al (2012), undertook a study on the Malaria in Pregnancy (MiP) in bibliometric review that was conducted on the contents of the Library to determine dynamics in the type, content and volume of literature on malaria in pregnancy over time. Data on year of publication, type, language, country of first-author affiliation and content were extracted from entries in the MiP Library and plotted over time. English-language articles were sourced from 737 different journals. The top three journals were the American Journal of Tropical Medicine and Hygiene, Malaria Journal and the Transactions of the Royal Society of Tropical Medicine and Hygiene. This showed that international journals were more preferred than local ones as could be seen from the findings of the Zambian study done by this researcher.

## 5. 6    Major Research Areas on Malaria

The study investigated on the research areas on Malaria from the 440 publications retrieved in PubMed/Medline. The distribution of the research publications on aspects of Malaria indicated that a significant number of authors wrote on general and unspecified aspects on malaria, while the lowest focused on the symptoms of malaria. It can be safely deduced and concluded that the major publications on malaria in Zambia had focused on the general aspects of Malaria. Factors leading these phenomena of higher number of publications focusing on general aspect of malaria and less on the specific aspects needs to be further studied.

The findings of the researcher outlined that major publications on malaria in Zambia were focused on the general aspects of Malaria. This is in contrast to the findings of Fu et al (2015), who conducted a study on bibliometric analysis of malaria research in China during 2004–2014.

The findings showed how China had made great progress in malaria prevention and control, even though there had been no research to provide a macroscopic overview of malaria research in China. The bibliometric analysis was conducted from international databases to explore the characteristics of malaria investigations in China. The source of data used was on Published scientific papers about malaria were retrieved from China National Knowledge Infrastructure (CNKI) Wanfang database and PubMed/Medline during 2004–2014. Year of publication, first-author affiliation, journal name and keywords were extracted with the Bibliographic Items Co-occurrence Matrix Builder (BICOMB). During the study a total of 5,126 entries were included in the period under review and it showed that the number of papers on malaria started to increase since 2010. The papers published by top 12 Chinese journals in the field of malaria accounted for 32.98% in overall articles. Most of the studies were conducted by the researchers from the Centers for Disease Control and Prevention (CDCs). In conclusion Chinese study on malaria mainly focused on the epidemiology and biomedical fields; the study offered a systematic evaluation on the output of malaria studies and the elimination of malaria in China.

The findings of this study also contrast the prevention and control study conducted by Waleed et al. (2017), study was carried out on the Bibliometric Analysis of Worldwide Publications on Antimalarial Drug Resistance from 2006–2015 which was more specific on prevention as compared to the findings of the researcher which showed less on the specific aspects needs. The study of Waleed et al. (2017) was in response to international efforts to control and eradicate malaria and designed to give a bibliometric overview of research productivity in antimalarial drug resistance (AMDR). Seven articles in the top-ten list were about artemisinin resistance in Plasmodium falciparum, one was about chloroquine resistance, one was about sulfadoxine-pyrimethamine resistance, and the remaining one was about general multidrug resistance which also showed a specific aspect and not a general.

Another study which conducted on a specific aspect of malaria was by Sweileh (2016), who carried out a study on emergence of insecticide resistance in malaria vectors was a real threat to future goals of elimination and control of malaria with the objective assess research trend on insecticide resistance of Anopheles mosquito contrasting the findings of this researcher as the findings were in general aspect. In specific, number of publications, countries, institutions, and

authors' research profile, citation analysis, international collaborations, and impact of journals publishing documents on insecticide resistance were presented. The United Kingdom (UK) ranked first in number of publications and Africa was the lowest, showing that International collaborations enhanced the knowledge about the situation of vector resistance in countries with endemic malaria.

## 5.7    Summary

This chapter discussed the findings of the study and it was observed that the number of publications output on malaria in Zambia was highest in the period 2011 to 2016, whilst the lowest being from the period 1961 to 1975.  This revealed that there was an increased trend in publications on malaria from the period in review. On organisations conducting research on malaria in Zambia, Research Medical Institutions had the majority share of Malaria research publications, while Government of the Republic of Zambia Malaria research publications were the lowest. This showed that research on malaria was mainly conducted by Research Medical Institutions. The authorship collaboration distribution patterns on articles on Malaria showed co-authored as being the highest, with the lowest being single authored. This brought to light that generally the number of co-authorship patterns on Malaria research publication ranged from one to five, with the 5 or more authorship collaboration pattern being the highest. The chapter further discussed on core journals in which research on malaria was published and discovered that of the 440 publications retrieved from PubMed/Medline, 16 journals contributed more of the Journals retrieved. The study revealed the highest number of malaria publications was the Malaria Journal and the lowest was the journals on the Annals of Tropical Medicine and the Parasitology journal implying that the Malaria Journal was the most considered journal for publication of research articles on malaria. The distribution of the research publications on aspects of Malaria indicated that a significant number of authors wrote on general and unspecified aspects on malaria, while the lowest focused on the symptoms of malaria. From this it can be concluded that the major publications on malaria in Zambia had focused on the general aspects of Malaria. Lastly the chapter included the researches done by other people.

## CHAPTER SIX: CONCLUSION AND RECOMMENDATION

### 6.1    Overview

This chapter presents the conclusion and recommendations centered on the findings of the study. It is divided into two parts; firstly, the conclusion and secondly, the recommendations. The study was undertaken to look at the informetric analysis of malaria research in Zambia from 1961 to 2016. Its attention was on the investigation of the research output on malaria in Zambia as retrieved from PubMed/Medline, identify organisations conducting research on malaria in Zambia, explore authorship collaboration in malaria research, identify the core journals in which research on malaria is published, and identify the major research areas on malaria in Zambia

### 6.2    Conclusion

The study has established that the number of publications output on malaria in Zambia was highest in the period 2011 to 2016 with the percentage of 45.2 (199) publications, whilst the lowest being from the period 1961 to 1975 with the percentage of 5 (2).  This revealed that there was an increased trend in publications on malaria from the period in review.

On organisations conducting research on malaria in Zambia, Research Medical Institutions had the majority share of Malaria research publications at 41.6% (183) while Government of the Republic of Zambia   Malaria research publications were at  2.7%(12). This showed that research on malaria was mainly conducted by Research Medical Institutions as indicated by publications at 41.6% (183).

The authorship collaboration distribution patterns on articles on Malaria showed that 54.5% (240) were co-authored by groups of more than five people, with the lowest of  four authorship collaboration pattern at 8.6 %(38) of the published articles on Malaria. This brought to light that generally the number of co-authorship patterns on Malaria research publication ranged from one to five, with the 5 or more authorship collaboration patterns being the highest.

Further, on core journals in which research on malaria was published, it was discovered that of the 440 publications retrieved from PubMed/Medline, 16 journals contributed 60.2% (265) of the Journals. The study found that highest number of malaria publications was in the Malaria Journal with a frequency of 101 (23.0%) and the lowest being in the Annals of Tropical Medicine and

the Parasitology journal with a frequency of 5 (1.1%), implying that the Malaria Journal was the most considered journal for publication of research articles on malaria with a frequency of 101(23.0%).

The distribution of the research publications on aspects of Malaria indicated that a significant number of authors 54.3% (239) authored on general and unspecified aspects on malaria, while the lowest 0.5% (2) focused on the symptoms of malaria. From this it can be safely said and concluded that the major publications on malaria in Zambia have focused on the general aspects of Malaria.

## 6.3 Recommendation

Based on the findings of the study, the following are some of the recommendations;

1. It was observed that the leading Institutions on malaria research output publications were international in nature and there was a low malaria research output publication from government related organizations in Zambia. It is therefore recommended that more local research publications must be conducted.
2. It is recommended that all types of authors should contribute equally to the authorship patterns in malaria research.
3. More local authors must be contributing to the journals in which research on malaria is published.

4. Since the study was limited to PubMed/Medline, any further research should be conducted to include other databases such as Scopus, Web of knowledge and Google scholar. Such a study will give a more comprehensive picture of the research output on malaria in Zambia

5. Another study can be conducted to establish the extent malaria research is being used following decisions and practices.

6. More Malaria research papers from public institutions should be published in the PubMed/Medline

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