2018

# Comparison of Malaria Control Interventions in Southern Africa

Ferdinand Nsengimana
*Walden University*

# Walden University

College of Health Sciences

This is to certify that the doctoral dissertation by

Ferdinand Nsengimana

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Ernest Ekong, Committee Chairperson, Health Services Faculty
Dr. Tolulope Osaba, Committee Member, Health Services Faculty
Dr. Jagdish Khubchandani, University Reviewer, Health Services Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2018

Abstract

# Comparison of Malaria Control Interventions in Southern Africa

by

Ferdinand Nsengimana

MPH, University of Namibia, 2011

BNS, University of Namibia, 2006

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health – Epidemiology

Walden University

November 2018

Abstract

There is lack of evidence on which of the two highly recommended malaria prevention methods, insecticide treated bednets and indoor residual spraying, is more effective than the other. There is also limited peer reviewed literature that compares the characteristics of people who use the two malaria prevention methods. Based on the Health Belief Model, the research questions tested whether there is any relationship between the use of mosquito bednet or the use of indoor residual spraying and contracting malaria, and whether there is any relationship between sociodemographic and socioeconomic factors and the use of malaria prevention methods. Using a quantitative research design, secondary data from the 2011 Angola malaria indicator survey were analyzed. Chi-square for association, logistic regression, and multinomial logistic regression tests were used. There was no statistically significant association between the use of mosquito bednet and having malaria. However, the use of indoor residual spraying significantly reduced the likelihood of getting malaria. There was also a statistically significant association between place of residence, wealth index, level of education, and number of household members and using mosquito bednet and between wealth index and using indoor residual spraying. In conclusion, the malaria prevention programs should focus on indoor residual spraying. It is recommended that all households in southern Africa malaria prone areas should be regularly sprayed. The findings of this study contribute to positive social change in the sense that by using more effective malaria prevention method, individuals will be able to function normally on daily basis, save on expenses related to employment loses or treatment and care of the sick, as well as loss of life and improve own economic status.

# Comparison of Malaria Control Interventions in Southern Africa

by

Ferdinand Nsengimana

MPH, University of Namibia, 2011

BNS, University of Namibia, 2006

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Philosophy

Public Health – Epidemiology

Walden University

November 2018

## Dedication

I dedicate this dissertation to all the Nsengimana and all the friends of the Nsengimana for their support during this academic journey. I further dedicate this dissertation to my dearest sister, brothers, and mother who prematurely left dad and I just because of an epidemic, and whose premature departure made me commit to becoming an epidemiologist one day, and here I am.

# Acknowledgment

I would like to acknowledge the Chair of my committee, Dr. Ernest Ekong, the committee member, Dr. Tolulope Osoba, and the University Research Reviewer, Dr. Jagdish Khubchandani for their guidance as I prepared this dissertation. I also would like to thank all the professors at Walden University who guided me through this academic journey. My special acknowledgment goes to the Demographic and Health Surveys (DHS) Program for granting me access to and allowing me to use their data for my dissertation.

Table of Contents

List of Tables

List of Figures

# Chapter 1: Introduction to the Study

Almost half of the world's population is at risk of malaria (World Health Organization, 2015). In 2013 alone, 198 million people got infected with malaria and half a million people died due to malaria (Centers for Disease Control and Prevention, 2015). While malaria cases increased, 214 million cases, the number of deaths due to malaria seem to have decreased, 438,000 deaths, according to September 2015 estimates (World Health Organization, 2015). However, sub-Saharan Africa seems to be the most affected region with 89% of all malaria cases and 91% of all malaria deaths coming from this region (White et al., 2013; World Health Organization, 2015).

The two highly recommended malaria prevention methods are insecticide-treated mosquito nets and indoor residual spraying (World Health Organization, 2015). Combining these two methods does not seem to give any better results in malaria prevention than using each method separately (Asidi, N'Guessan, Akogbeto, Curtis, & Rowland, 2012; Corbel et al., 2012). Furthermore, not all people who own mosquito nets sleep under them (Ankomah et al., 2012). There is no documentation about characteristic differences among users and non-users of malaria prevention methods. Knowing which of the two malaria prevention methods is more effective would ensure efficient interruption of the chain of infection and thus reducing the burden of malaria to individuals in particular and to the community in general. Knowing the characteristics of non-users would ensure that appropriate measures are taken in the implementation of the recommended prevention methods.

This Chapter will highlight the background of the study, problem statement, purpose of the study, research questions, nature of the study, theoretical foundation, assumptions and limitations of the study, delimitations, and significance of the study and will end with a summary of the chapter and transition to the next.

**Background of the Study**

Malaria is an infectious disease transmitted from human to human usually by an infected female *Anopheles* mosquito but can also be transmitted from animal to humans (Centers for Disease Control and Prevention, 2015). Malaria can be caused by any of the five parasite species namely *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale*, *Plasmodium malariae*, and *Plasmodium knowlesi* of which *Plasmodium falciparum* poses the greatest danger in Africa (World Health Organization, 2015).

Some successes in malaria reduction can be seen. Globally, there has been a decrease of 17% of malaria cases and 26% of malaria specific deaths between 2000 and 2010 (Cotter et al., 2013). The number of malaria cases in Africa decreased by 30% between 2004 and 2010 (Murray et al., 2012). This decrease is unlikely to be due to the newly tested malaria vaccine as this vaccine's effect tends to decline over time and with increased malaria exposure (Olotu, Fegan, Wambua, Nyangweso, & Awuondo, 2013) or the vaccine seems to offer only modest protection against malaria (Agnandji et al., 2012). Some researchers have attributed the decrease in malaria cases to the increased use of insecticide treated bednets, indoor residual spraying, and anti-malaria drugs (Bhatt et al., 2015; Aregawi et al., 2014). Insecticide treated bednets and indoor residual spraying are some of the common malaria control methods in Africa.

It seems to be unclear whether it would be more beneficial to use insecticide treated bednets and indoor residual spraying in combination or separately (World Health Organization, 2014). While some researchers did not find any benefit in combining insecticide treated bednets and indoor residual spraying (Asidi, N'Guessan, Akogbeto, Curtis, & Rowland, 2012; Corbel et al., 2012; Fullman, Burstein, Lim, Medlin, & Gakidou, 2013; Okumu, & Moore, 2011) other researchers have recommended using both methods (Bradley et al., 2012) while others have concluded that combining both methods was beneficial (West et al., 2015). There are other factors that may be worth considering such as the cost of each method, usability, and side effect.

The median cost of protecting one person for one year against malaria is three times higher for indoor residual spraying ($6.70), than insecticide treated bednets, ($2.20) (White, Conteh, Cibulskis, & Ghani, 2011). On one hand, treated bednets are only effective when people in areas at risk for malaria sleep under a bednet (World Health Organization, 2015). This may not be always a case. In fact, Ankomah et al. (2012) found that only a quarter of pregnant women who own mosquito nets slept under a net. Furthermore, Pulford et al. (2012) found that people do not use mosquito nets because they do not know how to use them but because they do not fear malaria as result of lived experience. Other people may use mosquito nets just to avoid the nuisance of mosquito bites (Beer et al., 2012). On the other hand, indoor residual spraying may require several spraying during malaria seasons and is only effective if at least 80% of houses have been sprayed (World Health Organization, 2015). While mosquitoes are likely to become resistant to chemicals used to treat mosquito nets (Ndiath, Mazenot, Sokhna, & Trape, 2014; Ranson et al., 2011; Trape et al., 2011) individuals who applied the indoor residual spraying as well as inhabitants of sprayed houses were having higher plasma levels of the sprayed chemicals that are potentially harmful to human health (Whitworth et al., 2014).

Despite the cost differences, usability, resistance, and possibility of used chemicals being potentially harmful to human health, insecticide treated bednets and indoor residual spraying have been in use either separately or in combination without evidence of which of these two methods is more effective in preventing malaria. Kigozi et al. (2012) assessed the effectiveness on indoor residual spraying but did not compare this method with any other malaria prevention methods. Therefore, there is a need to compare the effectiveness of mosquito bednets and indoor residual spraying in the prevention of malaria and the sociodemographic and socioeconomic characteristics of users and non-users of either prevention method.

## Problem Statement

Two main malaria prevention methods namely insecticide treated bednets and indoor residual spraying are recommended (World Health Organization, 2015). Although there is a global decrease in malaria cases and malaria specific mortality (Cotter et al., 2013), sub-Saharan Africa remains at greatest danger (White et al., 2013; World Health Organization, 2015). For example, in a period of six months, 57.8% of pregnant women at two health centers in Zambia were diagnosed with malaria (Chaponda et al., 2014) while in Mozambique the overall malaria prevalence among children aged 1 to 15 years was estimated at 47.8% (Temu, Coleman, Abilio, & Kleinschmidt, 2012). Some researchers could not establish any evidence that combining the two main malaria prevention methods would be more beneficial in the prevention of malaria than using each separately (Asidi, N'Guessan, Akogbeto, Curtis, & Rowland, 2012; Corbel et al., 2012; Fullman et al., 2013; Okumu, & Moore, 2011) while some other researchers established such a benefit (West et al., 2015). In areas where resources are limited, it may be necessary to choose one most effective method, considering that indoor residual spraying is 3 times more expensive than insecticide treated bednets (White, Conteh, Cibulskis, & Ghani, 2011), yet there is limited peer reviewed literature that compares the use of insecticide treated bednets and indoor residual spraying. Furthermore, there is limited peer reviewed literature that compares the sociodemographic and socioeconomic characteristics of people who use either and those who use neither of the two malaria prevention methods. Thus, the specific problems that this study addressed were to provide indications about whether the use of either mosquito bednets or indoor residual spraying is more effective than the other and to identify the sociodemographic and socioeconomic characteristics of who are likely to use either method or not.

## Purpose of the Study

The purpose of this quantitative study was to compare the effectiveness of mosquito bednets and indoor residual spraying in the prevention of malaria and to identify the sociodemographic and socioeconomic characteristics of people who use both methods, either, or neither method. Secondary data from surveys conducted in four southern African countries namely Angola, Namibia, Zambia, and Zimbabwe were requested from the Demographic and Health Surveys database. Participants were classified as whether they used a mosquito bednet or not, or lived in a sprayed house or not, and have had malaria or not. Furthermore, participants were classified based on some sociodemographic and socioeconomic characteristics such as number of household members, level of education, economic status, and place of residence and whether they used either mosquito bednets or indoor residual spraying or neither.

## Research Questions

This study attempted to answer the following research questions:

Research Question 1: What is the relationship between the use of mosquito bednet and contracting malaria?

Research Question 2: What is the relationship between the use of indoor residual spraying and contracting malaria?

Research Question 3: What is the relationship between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods?

## Theoretical Foundation

The researcher approached this study using the Health Belief Model (HBM). The key concepts of the HBM are susceptibility, seriousness, benefits and barriers, cues to actions, and self-efficacy (Champion & Skinner, 2008). This model was used by Wantanabe et al. (2014) to assess the determinant of the use of insecticide-treated bednets while Beer et al. (2012) used this model to explore the perception of malaria and bednet use. Other researchers used this model looking at the concept of seriousness, or severity, of malaria (Pulford, Oakiva, Angwin, Bryant, Mueller, & Hetzel, 2012). The researcher intended to determine whether using either indoor residual spraying or mosquito bednet is more beneficial in terms of malaria prevention with the hope that clarifying such benefit, if any, would help the users to overcome the barriers such as cost or potential health risks. Furthermore, the researcher intended to determine whether there are any sociodemographic or socioeconomic characteristic differences between users and non-users of malaria prevention methods. Knowing such characteristics would guide health professionals on how to effectively target the non-users and hopefully get them to start using the recommended methods.

## Nature of the Study

To determine whether using either mosquito bednets or indoor residual spraying is more beneficial than the other and whether there are some characteristic differences between people who use either and people who use neither of the methods a quantitative research using secondary data analysis of cross-sectional surveys data was done. Secondary data analysis technique was appropriate as the researcher planned to have an access to a larger sample size but had limited resources such as money and time (Laureate Education, Inc., 2012). The researcher combined and analyzed data from several countries in southern Africa and it would have been too costly in terms of money and time for the researcher to collect primary data.

In this study, the independent variable was the use of recommended malaria prevention methods namely mosquito bednets and indoor residual spraying while the dependent variable was malaria status. Furthermore some characteristics such as number of household members, level of education, economic status, and place of residence were used as independent variables and the use of malaria prevention method as the dependent variable.

Secondary data were requested from the Demographic and Health Survey database. Specifically, a request was made for four southern African countries namely Angola, Namibia, Zambia, and Zimbabwe. These four countries have freely availed their Demographic and Health Survey data and together with other southern African countries namely Botswana, Mozambique, South Africa, and Swaziland, decided to joint efforts towards malaria elimination (Cotter et al., 2013).

The IBM SPSS version 21 software was used to analyze data. The statistical tests included the Pearson's chi-square test, Cramér's *V*, and loglinear analysis. When assessing the relationship between two categorical variables, Pearson's chi-square test is said to be a highly elegant statistic for comparing the observed and expected frequencies in the categories (Field, 2013). However, according to Field (2013), Pearson's chi-square test is best fit when both variables have only two categories. Should variables have more than two categories, then the Cramér's *V* is recommended. Furthermore, Pearson's chi-square and Cramér's *V* are used when there are only two categorical variables. Should there be more than two categorical variables, then the loglinear analysis is recommended (Field, 2013). These statistics are described in more details in Chapter 3.

## Definitions

*Indoor residual spraying*: Indoor residual spraying refers to the coating of the walls and other surfaces of a house with an insecticide that will remain active for several months (Centers for Disease Control and Prevention, 2012)

*Malaria*: Malaria is disease transmitted to human through bites of infected female mosquitoes (World Health Organization, 2015).

*Insecticide treated bednet*: An insecticide treated bednet is a net treated in the factory and does not require any further treatment or a net that has been socked with insecticide within the last 12 months (Ministry of Health and Social Services & Namibia Statistics Agency, 2014).

*Socioeconomic factors*: Socioeconomic factors refer to those social and economic factors such as income and education level (Ren et al., 2016) that are used to compare someone's social and economic position to that of others.

## Assumptions

The researcher assumed that the data would be available and accessible. Researchers who plan to use secondary data are challenged when data is unavailable or difficult to retrieve (Mungrue et al., 2015). The researcher further assumed that the data would be of acceptable quality to answer the proposed research questions as the researcher did not have any control over the quality of those data (Laureate Education, Inc., 2012).

## Scope and Delimitations

The researcher focused on comparing the effectiveness of mosquito bednets to that of indoor residual spraying as malaria prevention methods. These two methods are recommended with conflicting indication on whether they should be used in combination or separately and with no indication of which method is more effective than the other. There may be other methods that may be contributing to the prevention of malaria but not recommended as major prevention methods and thus they were not assessed in this study. The researcher further attempted to determine whether there are sociodemographic or socioeconomic characteristic differences among individuals who use both, either, or neither mosquito bednet or indoor residual spraying. The literature search did not provide clear guidance on who is likely to use a malaria prevention method or not yet such information could help in malaria prevention program implementation.

This study was delimited to the population in southern African countries where primary data were collected and availed. Thus the results are valid and generalizable to the specific countries in southern Africa and cannot be generalized to other regions such as entire sub-Saharan Africa or entire Africa.

## Limitations

The researcher could not control the data collection procedure since the study was based on the analysis of secondary data. Researchers who use secondary data have no control over the sample, constructs to be measured, or how constructs are measured (Greenhoot & Dowsett, 2012). One more limitation could be that, since some of the data from Demographic and Health Surveys such as the ones the researcher intends to request for this study are freely available, another researcher could be working on the same data with similar questions as those in this study. Thus, it could be possible that someone else publishes a similar study before this one is concluded (Greenhoot & Dowsett, 2012; Smith et al., 2011).

## Significance of the Study

This study is significant as its findings could guide public health officials and/or policy makers in making informed decision on which of the two approaches to take in the prevention of malaria: mosquito bednets or indoor residual spraying. The findings could also inform the potential users whether to buy mosquito bednets or to get their houses sprayed. This research was unique because it compared two malaria prevention methods in order to decide which one is more effective than the other.

On one hand, literature search indicated that researchers either ruled out any additional benefit of combining indoor residual spraying and insecticide treated bednets (Asidi, N'Guessan, Akogbeto, Curtis, & Rowland, 2012; Corbel et al., 2012; Fullman, et al., 2013; Okumu, and Moore (2011) or concluded that such additional benefit exists (West et al., 2015). On the other hand some researchers found a significant relative risk reduction of parasitemia in high malaria transmission areas for mosquito nets use alone but not for indoor residual spraying alone while in medium malaria transmission areas either method had a significant relative risk reduction of parasitemia (Fullman et al., 2013). While a mathematical modeling study showed that indoor residual spraying alone could be up to ten times more effective than mosquito bednet use alone (Yakob, Dunning, and Yan, 2010), Kleinschmidt et al. (2009) found a protective effect on malaria transmission for both mosquito net use and indoor residual spraying but did not compare which of these two methods had a better protection than the other. The researcher contributed to this field of knowledge through this study by comparing the two malaria prevention methods.

Knowing and implementing a malaria prevention method which is more effective would contribute to positive social change through improved users' health by preventing malaria. For example, it is estimated that preventing malaria would result in US $208.6 billion gain (Purdy, Robinson, Wei, & Rublin, 2013) and for every $1 invested per capita in malaria prevention in Africa the per capita gross domestic product increases by $6.75 (Jobin, 2014). Furthermore, using the most effective malaria prevention method would reduce the double effects of chemicals used which are believed to be potentially harmful to human health (Whitworth et al., 2014).

## Summary and Transition

With almost half of the world's population being at risk of malaria, 89% of all malaria cases and 91% of all malaria deaths come from sub-Saharan Africa. The two highly recommended malaria prevention methods are insecticide treated bednets and indoor residual spraying. It is however unclear whether it would be more beneficial to use mosquito bednets and indoor residual spraying in combination or separately. Furthermore, there is limited peer reviewed literature that compares the sociodemographic and socioeconomic characteristics of people who use either and those who use neither of the two malaria prevention methods. Thus, the specific problems that this study addressed are the lack of indications about whether the use of either mosquito bednets or indoor residual spraying is more effective than the other and lack of clear sociodemographic and socioeconomic characteristics of people who are likely to use either method or not.

Chapter 1 highlighted the background of the study, problem statement, purpose of the study, research questions and hypotheses, nature of the study, theoretical foundation, assumptions and limitations of the study, delimitations, and significance of the study. A review of the literature is presented in Chapter 2.

# Chapter 2: Literature Review

There are no indications on whether the use of either insecticide treated bednets or indoor residual spraying is more effective than the other in the prevention of malaria. Furthermore, there are no clear sociodemographic and socioeconomic characteristics of people who are likely to use either method or not. The purpose of this quantitative study was to compare the effectiveness of mosquito bednets and indoor residual spraying in the prevention of malaria and to identify the sociodemographic and socioeconomic characteristics of people who use and those who do not use either method.

Malaria poses a great danger in the sub-Saharan region where 89% of all malaria cases and 91% of all malaria deaths come from (White et al., 2013; World Health Organization, 2015). The pooled prevalence of peripheral malaria among pregnant women attending antenatal care facilities in sub-Saharan Africa was 32% in east and southern Africa and 38% in west and central Africa with this prevalence going as high as 95% in Cameroon and 88% in Uganda (Chico et al., 2012). In a period of six months, 57.8% of pregnant women at two health centers in Zambia were diagnosed with malaria (Chaponda et al., 2014) while in Mozambique the overall malaria prevalence among children aged 1 to 15 years was estimated at 47.8% (Temu, Coleman, Abilio, & Kleinschmidt, 2012).

This chapter will cover the literature search strategy, theoretical foundation of the study, burden of malaria, risk factors for malaria, recommended malaria prevention methods, the sociodemographic and socioeconomic factors associated with the use of bednets and/or indoor residual spraying, and the researchers' approach to malaria prevention methods related studies, then the summary and conclusion.

## Literature Search Strategy

Information for the literature review was obtained by searching Walden University electronic databases such as Thoreau Multi-Database Search, Academic Search Complete, ProQuest Central, and ScienceDirect as well as ProQuest Dissertations & Theses Global and ProQuest Dissertations & Theses @ Walden University. Google Scholar was also used particularly searching for articles that could be found at Walden University and could be freely accessed. Key words such as *malaria, malaria prevention, malaria prevention methods, malaria and mosquito bed nets use,* and *malaria and indoor residual spraying, reasons for decrease in malaria cases, malaria in Africa, malaria in sub-Saharan Africa*, were used to search the data bases. The search was restricted to peer-reviewed articles published in English since year 2012 to current.

## Theoretical Foundation

The health belief model is widely used to explain changes in health related behaviors and to guide health behavior interventions (Champion & Skinner, 2008). Health belief model was developed by social psychologists in public service in the 1950s to understand why people resisted participating in disease prevention and detection. The model was later extended by cognitive theorists who believed that a behavior is influenced by an outcome and the probability of such a behavior achieving such an outcome (Champion & Skinner, 2008).

Researchers have used the health belief model to explore the perceptions and beliefs about malaria and the use of insecticide treated bednets (Beer et al., 2012; Noriko et al., 2014), to investigate the factors that influence pregnant women in rural and urban areas to seek treatment for malaria (Onabanjo & Nwokocha, 2012), to examine malaria self-care motivating factors among adults (Metta, Haisma, Kessy, Hutter, & Bailey, 2014) and to investigate the motivating factors for net care and repair behaviors (Loll et al. 2014). The basic components of this model are perceived threat, perceived benefits, perceived barriers, cues to action, self-efficacy, and other modifying variables (Champion & Skinner, 2008; Clemow, 2004).

Perceived threat entails that people should not only believe that they are at a danger in order for them to take protective measures but also that this danger should be severe enough to cause problem and the risk should be real for the concerned people. For example, people in malaria endemic area are at risk of getting malaria and should think about taking protective measures while those in non-endemic area are not at risk and therefore may not need to take any protective measures.

Perceived benefits refer to the positive effect of taking action. For example if having malaria is so disturbing that one would be better off without it, then one is likely to take preventive measures. The opposite to this is perceived barriers where by negative consequences or the cost of a preventive action would prevent one from taking such action. For instance, people may perceive that paying for a mosquito bednet is too expensive where malaria treatment is given free of charge.

Cues to action refer to the internal or external reminders to take action while self-efficacy refers to one's confidence in performing a particular act. Other modifying variables include all other variables that may act as moderator or mediator such as age, socioeconomic status, and educational level just to mention but a few.

Knowing which malaria prevention method is most effective and the sociodemographic as well as socioeconomic characteristics of people who use both, either, or neither method could guide researchers and public health officials who plan to use health belief model in malaria prevention. Question 1 and 2 targeted the benefit and threat components of the health belief model while Question 3 addressed the barriers and other modifying factor components. The following section of this chapter discusses the burden of malaria.

## Burden of Malaria

Malaria is an infectious disease transmitted from human to human usually by an infected female *Anopheles* mosquito but can also be transmitted from animal to humans (Centers for Disease Control and Prevention, 2015, 2016a). While *Plasmodium falciparum* poses the greatest danger in Africa, other species such as *P. vivax, P. ovale, P. malariae, and P. knowlesi* can also cause malaria (World Health Organization, 2015). In 2015 alone, 214 million cases of malaria and 438,000 malaria related deaths, most of the dead being children, were reported (Centers for Disease Control and Prevention, 2016a). More than 90% of malaria related deaths occur in Africa (Centers for Disease Control and Prevention, 2016b; Karunamoorthi, 2012). This comes with a serious economic impact. The sick person may not be as productive as the non-sick ones.

People either spend money or other resources on seeking preventive or medical care, or become unable to work repeatedly. In Kenya, people who get malaria have a wage earning which is 44% lower than that of those who do not get malaria (Kioko, Mwabu, & Kimuyu, 2013). The annual cost of malaria treatment in children was estimated around US$ 38 million in Ghana, US$ 109 million Kenya, and US$ 132 million in Tanzania (Sicuri, Vieta, Lindner, Constenla, & Saunpin, 2013). In southeast Nigeria, treating one case of malaria per year would cost USD 176 in the outpatient department and USD 1,928 in the inpatient department (Onwujekwe, Uguru, Etiaba, Chikezie, Uzochukwu, & Adjagba, 2013). All these result in reduced economic growth (Karunamoorthi, 2012). While malaria may lead to poverty on one hand, being poor on the other hand seems to be one of the risk factors for malaria.

## Risk Factors for Malaria

One of the risk factors for malaria is poverty (Bi & Tong, 2014). Researchers in Malawi found that socio-economic status was an important determinant of malaria morbidity (OR = 0.96; 95% CI 0.32 – 0.77) (Chitunhu & Musenge, 2015). In north-west Tanzania, community poverty is a risk factor for malaria after short rains (OR=0.13; 95% CI 0.05 – 0.34) while both community poverty (OR=0.26; 95% CI 0.15 – 0.44) and household poverty (OR=0.89; 95% CI 0.82 – 0.97) are risk factors for malaria after long rains (West et al., 2013). In Nigeria researchers found that the level of wealth in the community (OR = 0.51; 95% CI 0.34 – 0.76) was negatively associated with child malaria (Kyu, Georgiades, Shannon, & Boyle, 2013). Hanandita and Tampubolon (2016) concluded that malaria is a disease of poverty. Parents may choose to use mosquito nets for other purposes such as fishing not because they are ignorant but due to the fact that poverty obliges them to do otherwise (Ingstad, Munthali, Braathen, & Grut, 2012). The malaria and poverty cycle has been referred to a malaria trap whereby malaria reinforces poverty and poverty reduces the ability to deal with malaria (Berthélemy, Thuilliez, Doumbo, & Gaudart, 2013). In a systematic review and meta-analysis study, researchers found that the odds of malaria infection were higher among the poorest than the least poor children (OR = 1.66; 95% CI 1.35 – 2.05, $p < 0.001$ (Tusting et al., 2013). Using the national malaria survey data, Njau, Stephenson, Menon, Kachur, and McFarland (2013) found that Angolan children from wealthier families were 6.4 percentage points less likely to test positive for malaria than those in poorest families, whereas children from Tanzania and Uganda were less likely to test malaria positive for malaria by 7 and 11.6 percentage points respectively ($p < 0.001$). However, De Castro and Fisher (2012), based on their findings from nationally representative data in Tanzania which shows that households with a child who was malaria positive during the survey had a wealth index of 1.9 units lower ($p < 0.001$) and that the increase in wealth had no significant effect on malaria, concluded that malaria could be a cause rather than a consequence of poverty.

Deforestation is another factor associated with malaria. In the Amazon, there are more people suffering from malaria in areas of high compared to areas of low deforestation practice (Barros & Honorio, 2015; Guimaraes et al., 2016; Hahn, Gangnon, Barcellos, Asner, & Patz, 2014). This could be because mosquitoes survive and develop easily in deforested areas (Kar, Kumar, Singh, Carlton, & Nanda, 2014; Wang et al., 2016). The settling of an increased number of new comers, who may be less immune or live in less protected structures, could also contribute to the high rate of malaria at deforestation sites (Valle & Clark, 2013). This shows the link between place of residence and malaria.

People who live in close vicinity with dams in sub-Saharan Africa (Kibert, Lautze, Boelee, & McCarthey, 2012; Kibret, Lautze, McCartney, Wilson, & Nhamo, 2015) or those who live in irrigated villages in Ethiopia (Kibret, Wilson, Tekie, & Petros, 2014) are more at risk of getting malaria. Seasonality however appears to be more linked to malaria than the presence of dams. In their studies, Yewhalaw et al. (2013) found no significant variations in malaria incidences among children who live closer and those who live far away from a dam but the malaria seasonal variations were significant. The rate of malaria transmission was found to be higher among children who live in areas of high seasonality (Cairns et al. 2015). In Kenya highlands, infants and adults had a high prevalence of asymptomatic parasitology during low as well as high transmission season compared to children while new clusters for clinical malaria emerged during peak season (Zhou, Afrane, Malla, Githeko, & Yan, 2015). Malaria transmission was found to be high during rainy season in Western Kenya (Sewe, Ahm, & Rocklöv, 2016). Seasonality was found to be mild for *P. vivax* among young children but marked for *P. falciparum* among older children (Seyoum et al., 2016). In Accra, Ghana, malaria was found to be associated with variations in annual and monthly rain fall (Donovan, Siadat, & Frimpong, 2012). Since the malaria risk varies from place to place, people who travel to high malaria risk places are likely to be exposed to malaria.

Cases of clinical malaria have been recorded among non-immune travelers to malaria endemic areas. Texier, Machault, Barragti, Boutin, and Rogier (2013) found an incidence density of 7.4 clinical malaria episodes per 1,000 person-months. However, it may also happen that malaria infected people travel and export or import malaria to non-malaria areas. Dougnon et al. (2015) tested patients visiting an aviation clinic in Nigeria for malaria and found that 22% of patients were malaria positive on microscopic examination compared to about 10% malaria positive using rapid diagnostic test. In Canada, malaria contributes 2.1% of travel related diagnoses (Boggild et al., 2016). In the UK, the number of imported malaria was 1400 cases in 2015, the lowest number being 1370 cases in 2008, and the highest being 2500 cases in 1996 (Public Health England, 2016). The challenge is that when these malaria infected people arrive in a non-malaria regions, it takes time before they are diagnosed and treated for malaria (Dotrario et al., 2016; Tan, Cullen, Koumans, & Arguin, 2016). During this time, mosquitoes can feed on these people and transmit malaria to others since the absence of malaria does not necessarily mean the absence of malaria transmitting mosquitoes. For example, indigenous malaria has been eliminated in Sri Lanka but several species of mosquitoes including those that are potential malaria vectors are found in agro wells, granite, and clay quarry pits (Fernando et al., 2016).

Furthermore, these malaria carriers may donate blood and the recipients may contract malaria in the absence of proper blood screening. In Ghana, 10% of blood donors are parasitaemic of malaria (Owusu-Ofori, Gadzo, & Bates, 2016). Parasitaemia of malaria among healthy blood donors has been documented in São Paulo (Maselli et al.,

2014) and India (Negi, Gupta, Srivastava, & Gaur, 2014) while cases of malaria infection from blood transfusion have been reported in Malaysia (Anthony et al., 2013), Ghana (Owusuku-Ofori, Betson, Parry, Stothard, & Bates, 2013), as well as other countries in sub-Saharan Africa (Owusu-Ofori, Owusu-Ofori, & Bates, 2015). Given the scarcity of blood donors and the high need for blood transfusion, it may impractical to reject blood harvested from malaria infected donors (Nansseu, Noubiap, Ndoula, Zeh, & Monamele, 2013). It is thus important to see that people prevent getting malaria in the first place and some of the methods recommended by the World Health Organization are the application of indoor residual spray and the use of mosquito bednets.

## Recommended Malaria Prevention Methods

The two highly recommended malaria prevention methods are insecticide-treated mosquito nets and indoor residual spraying (World Health Organization, 2015). It is however not clear whether using these two methods in combination would be more beneficial than using one method without the other.

Some researchers found a significant effect of combining insecticide-treated mosquito nets and indoor residual spraying in the prevention of malaria. Combined use of insecticide-treated mosquito nets and indoor residual spraying significantly reduced parasitemia in medium and high malaria transmission area, 53% (95% CI 37% to 67%) and 31% (95% CI 11% to 47%) respectively (Fullman et al., 2013). In their randomized trial study, West et al. (2013) found a mean malaria prevalence rate of 13% among those who used both insecticide treated bednets and indoor residual spraying compared to 26% among those who used insecticide treated bednets alone (OR = 0.43; 95% CI 0.19 – 0.97,

$n$ = 13,146). West et al. concluded that indoor residual spraying could be beneficial where people use mosquito bednets inconsistently but warn about the cost effectiveness of combining the two malaria prevention methods. A cluster randomized trial study in Tanzania showed that the area where both indoor residual spraying and mosquito bednets were in use recorded a reduction of 84% in the anopheles mosquito population (95% CI 56% - 94%, $p$ = 0.001) relative to area where only mosquito bednets were in use (Protopopoff et al., 2015).

Some other researchers did not find a significant difference between combining insecticide-treated mosquito nets and indoor residual spraying or using mosquito nets alone. Pinder et al. (2015) found no significant difference in clinical malaria among children who used mosquito bednets alone and those who combined indoor residual spraying and mosquito bednets. Pinder et al. found an incidence of clinical malaria of 0·047 per child-month at risk among children who used mosquito bednets and 0·044 per child-month at risk among children who combined both indoor residual spraying and mosquito bednets in 2010, and 0·032 per child-month at risk among children who used mosquito bednets and 0·034 per child-month at risk among children who combined both indoor residual spraying and mosquito bednets in 2011.

Some of the limitations in the reviewed studies included the inability to mask the communities to interventions which could result in under-reporting of signs and symptoms of malaria in the treatment group thus falsely indicating an increased effectiveness of the intervention, inability to avoid spillover, convenience selection of villages, and mosquito resistance to some chemicals used in indoor residual spraying

(Pinder et al., 2015). Furthermore, small sample size in mortality, residual confounding in a non-randomized study, inability to investigate the effect of intervention integrity, and inability to consider community level effects of the interventions (Fullman et al., 2013) were also identified as limitations.

Recommendations for further studies included the need of understanding the relationship between child mortality and the mosquito nets use as well as indoor residual spraying (Fullman et al., 2013), the need to investigate the spread of insecticide resistance (Pinder et al., 2015), and the need for trial studies to compare the use of indoor residual spraying combined with mosquito nets to each of these methods alone (West et al., 2013). Other researchers recommended that studies should be undertaken to evaluate the effectiveness of the current malaria prevention methods especially when implemented on a larger scale (Njau, Stephenson, Menon, Kachur, & McFarland, 2013). The proposed study is based on this recommendation.

Although findings on the combined use of insecticide-treated mosquito nets and indoor residual spraying are controversial, used separately, each of the two malaria prevention methods seems to significantly reduce malaria incidences. Steinhardt et al. (2013) conducted a cross-sectional household survey in three malaria high-transmission districts of Uganda and found lower parasitemia prevalence among children living in two previously sprayed district compared to the non-sprayed district: 37.0% and 16.7% versus 49.8%, $p < 0.001$. However, the effect of indoor residual spraying reduces as the time after last pray increases. In a study conducted in Equatorial Guinea using data from the 2011 annual malaria indicator survey and from standard World Health Organization cone bioassays Bradley et al. (2012) found that the prevalence of malaria infection in two to 14 year-olds in 2011 increased from 18.4% to 21.0% then to 28.1% after three, four, and five months of indoor residual spraying respectively. Repeated indoor residual spraying seems to be beneficial in malaria prevention in areas of low to moderate mosquito bednet usage. Gimning et al. (2016) conducted surveys in a Kenyan district that received indoor residual spraying and its neighboring district that was not sprayed. The researchers found a similar prevalence of malaria parasitemia in the two districts at baseline and after the first round of indoor residual spraying. However, after the second round of indoor residual spraying the prevalence of malaria parasitemia was 6.4% in the sprayed district compared to 16.7% in the non-sprayed district (OR = 0.36; 95% CI = 0.22 – 0.59, $p < 0.001$). The challenge is that indoor residual spraying does not seem to prevent mosquitoes from entering a house. In their study, Okumu et al. (2013) found that more than 95% of mosquitoes were caught while exiting. This would mean that these mosquitoes could have taken a bite unless people were protected by mosquito nets. It is this recommended that people use mosquito nets especially in areas where resources are scarce (Okumu, Kiware, Moore, & Killeen, 2013; Okumu et al., 2013).

Mosquito nets alone can prevent more than 99% of indoor mosquito bites while only some types of treatment used in indoor residual spraying significantly increase mosquito mortality compared to mosquito nets alone (Okumu et al., 2013). A lower incidence of malaria infection, 1.7 infections per person-year (95% CI 1.5 – 2.1), was reported among people who use bed nets compared to 2.6 infections per person-year (95% CI 2.0 – 3.3) with a 30% reduction (rate ratio 0.7; 95% CI 0.5 – 0.8) of incidence of malaria infections among bed nets users compared to non-users (Lindblade et al., 2015). Insecticide treated bed nets are more effective in preventing malaria than untreated bed nets regardless of the mosquito resistance level (Strode, Donegan, Garner, Enayati, & Hemingway, 2014).

**Factors Associated with Use of Bednets and/or Indoor Residual Spraying**

In a population-based cross-sectional survey of households headed by females in Mozambique, researchers found that factors associated with the use of mosquito bednets were higher education, understanding of official language, larger household size, having electricity in the household, and high monthly income (Moon et al., 2016). These researchers also found that per 1 hour increase in the time it takes to reach the health facility the odds of using a mosquito net reduced by 13% (OR 0.87; 95 % CI 0.74–1.01, $p = 0.07$). Other researchers in Ghana found that children in households that are headed by males were more likely to sleep under a mosquito net ($p = 0.0001$) (Owusu Adjah, & Panayiotou, 2014). Wealthier families were found to have a higher margin of using mosquito bednets than poorest families in Tanzania and Uganda by 11.4% and 3.9% respectively while in Angola the poorest people had a 6.1% mosquito bednet use advantage over wealthier people (Njau, Stephenson, Menon, Kachur, & McFarland, 2013).

The literature on the sociodemographic and socioeconomic factors associated with the use of indoor residual spraying is limited. Dimas (2017) found that age was a statistically significant factor associated with acceptability of indoor residual spraying as well as, although not statistically significant, having primary or lower education, being a head of the household, and being a farmer. Munguambe et al. (2011) qualitatively explored the reasons for adherences to indoor residual spraying in rural Mozambique and respondents did not refer to sociodemographic or socioeconomic factors. While a study conducted in Northern Uganda indicated that indoor residual spraying could effectively reduce malaria (Tukei, Beke, & Lamadrid-Figueroa, 2017), a cross sectional study conducted in Seroti district, Uganda indicated that more than half of the respondents had no knowledge about indoor residual spraying and that knowledge about residual indoor spraying was associated with urban residency (AOR 1.92; 95% CI 1.04 – 3.56), and higher level of education (AOR 4.81; 95% CI 2.72 – 8.52) (Ediau et al. 2013). Furthermore, there are some people who believe that indoor residual spraying does not reduce mosquitoes or malaria (Munguambe et al., 2011).

The results from Tukei et al. (2017) should be interpreted with caution as the study lacked a control group and had a smaller sample size.

## Researchers' Approach to Malaria Prevention Methods Related Studies

Some of the studies reviewed in this literature were cross-sectional studies based on national malaria indicator surveys (Bradley et al., 2012; Chitunhu & Musenge, 2015; De Castro & Fisher, 2012; Kyu, Georgiades, Shannon, & Boyle, 2013; Steinhardt et al., 2013) or multinational malaria indicator surveys (Fullman et al., 2013; Njau, Stephenson, Menon, Kachur, & McFarland, 2013). Cross-sectional studies have several advantages and disadvantages. One particular advantage is that they are relatively quick and easy to conduct with no need of long periods of follow-up. However, cross-sectional studies are unable to measure incidence and are susceptible to bias incidence-prevalence bias and temporal bias (Szklo & Nieto, 2014).

Other researchers used randomized trial (Pinder et al., 2015; Protopopoff et al., 2015; West et al., 2013) while others used systematic review and meta-analysis (Tusting et al., 2013). Randomized controlled trials allow the researcher to remove population bias but are expensive in terms of time and money (The Himmrlfarb Health Sciences Library, 2011). While systematic reviews and meta-analysis may allow the researcher to generalize findings to the general population more broadly than individual studies systematic reviews can be time consuming and combining studies may be difficult (The Himmrlfarb Health Sciences Library, 2011)

Most studies either compared the combination of both mosquito bednets use and indoor residual spraying to bednets use alone (Fullman et al., 2013; Protopopoff et al., 2015; West et al., 2013) or assessed the effectiveness of either method separately in the prevention of malaria (Pinder et al., 2015; Steinhardt et al., 2013; Bradley et al., 2012; Gimning et al., 2016; Okumu et al., 2013; Lindblade et al., 2015; Strode, Donegan, Garner, Enayati, & Hemingway, 2014). My literature search showed limited studies that compare the effectiveness of mosquito bednets use to that of indoor residual spraying to allow one make informed decision in choosing which of the two methods to use. Furthermore, my literature search showed limited studies highlighting the sociodemographic and/or socioeconomic factors associated with use of indoor residual spraying.

## Summary and Conclusions

Malaria poses a great danger in the sub-Saharan region where 89% of all malaria cases and 91% of all malaria deaths come from. Malaria is transmitted from human to human usually by an infected female *Anopheles* mosquito but can also be transmitted from animal to humans. In 2015 alone, 214 million cases of malaria and 438,000 malaria related deaths, most of the dead being children, were reported. The risk factors for malaria include poverty, deforestation, area of residence, travelling to or from malaria areas, as well as blood transfusion.

The two highly recommended malaria prevention methods are insecticide-treated mosquito nets and indoor residual spraying. My literature search revealed contradicting results. Some researchers found that combining both methods was more beneficial than using mosquito nets without indoor residual spraying while others researchers did not find such benefit. My literature search did not reveal any study comparing the use of mosquito nets to indoor residual spraying separately. While some of the factors associated with the use of mosquito nets are the heads of household as well as the household's wealth, my literature search did not reveal any study highlighting the sociodemographic and/or socioeconomic factors associated with indoor residual spraying.

Based on this review, I used secondary data from the Demographic Health Surveys to examine the relationship between the independent variables use of mosquito bednets and indoor residual spraying and the dependent variable malaria status as well as the independent variables sociodemographic and socioeconomic factors and the dependent variables use of mosquito bednets and use of indoor residual spraying. A complete description of the study design and methodology is presented in Chapter 3.

# Chapter 3: Research Method

The purpose of this quantitative study was to compare the effectiveness of mosquito bednets and indoor residual spraying in the prevention of malaria and to identify the sociodemographic and socioeconomic characteristics of people who use both methods, either, or neither method. In this Chapter, the researcher will discuss the research design and rational as well as the methodology for this study including components such as target population, data collection procedure for using secondary data, and the strategy for recruitment, sampling, and data collection instruments used in the original studies. The researcher will further discuss the data analysis plan followed by a discussion on the threats to validity and how these threats were mitigated and will conclude this Chapter with a description of ethical issues that were adhered to.

## Research Design and Rationale

This study was a cross-sectional quantitative study that used secondary data from Demographic and Health Surveys (DHS) Program. The researcher measured and analyzed the relationship between the study variables without manipulating the study environment and thus considered a cross-sectional design appropriate for this study. A cross-sectional design allows for comparing groups or variables at a given time point (Smith et al., 2011). For example, users and non-users of a particular malaria prevention method can be compared on the malaria status variable. Cross-sectional design is commonly used in social sciences when diseases prevalence and effectiveness of public health interventions are measured (Frankfort-Nachmias & Nachmias, 2008). Furthermore, cross-sectional studies are less expensive in term of data collection (Smith et al., 2011). Data were already available for the study and the researcher had been granted permission to use these data. Experimental designs could not be appropriate in this study especially when the researcher would have to prevent subjects in the control group from using a particular malaria prevention method for the sake of just comparing the outcome (Creswell, 2009), in this case malaria status. The researcher provided a correlational and predictive relationship among variables and did not establish cause-effect relationships. Furthermore, experimental designs would have been too expensive in terms of time and money (Smith et al., 2011) and the researcher lacked the necessary resources.

**Research Questions and Hypotheses**

The following quantitative research questions and hypotheses guided this study:

*RQ 1*: What is the relationship between the use of mosquito bednet and contracting malaria?

$H_01$: There is no association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do not report lower malaria prevalence than non-users.

$H_a1$: There is an association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do report lower malaria prevalence than non-users.

*RQ 2*: What is the relationship between the use indoor residual spraying and contracting malaria?

*$H_0$2*: There is no association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do not report lower malaria prevalence than non-users.

*$H_a$2*: There is an association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do report lower malaria prevalence than non-users.

*RQ 3*: What is the relationship between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods?

*$H_0$3*: There is no association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are similar among those who use both, either, or neither of the malaria prevention methods.

*$H_a$3*: There is an association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are different among those who use both, either, or neither of the malaria prevention methods.

### Variables

Based on these research questions, the independent variable in this study was the use of recommended malaria prevention methods namely mosquito bednets and indoor residual spraying while the dependent variable was malaria status. Furthermore some characteristics such as number of household members, level of education, economic status, and place of residence were used as independent variables with the use of malaria prevention method as the dependent variable. The measurement scales were nominal, ordinal, and interval. Variables and their level of measurement are listed in Table 1.

*Table 1: Study Variables and their Measurement Scales*

| Variable | Level of Measurement |
|---|---|
| Children under 5 slept under mosquito bed net last night | Nominal |
| Has dwelling been sprayed against mosquitoes in last 12 months | Nominal |
| Number of household members | Interval |
| Highest educational level attained | Ordinal |
| Wealth index | Ordinal |
| Type of place of residence | Nominal |
| Final result of malaria from blood smear test | Nominal |

## Methodology

### Population

The target population for this study comprised of all households in four southern African countries namely Angola, Namibia, Zambia, and Zimbabwe. The estimated number of privately owned households were 2,769,000 in Angola (AreaConnect, 2016), 21,283 in Namibia (Namibia Statistics Agency, n.d.), 2,815,897 in Zambia (Central

Statistical Office et al, 2015), and 3,059,016 in Zimbabwe (Zimbabwe National Statistics Agency, n.d.).

**Sampling and Sampling Procedures**

When conducting a research, it may be impossible to include an entire population of interest. In such case, some units are selected from the population of interest and used to understand a specific phenomenon about that population. The process of selecting units from a population of interest is referred to as sampling. Sampling allows the researcher to draw conclusions from a subset and make generalization to the entire population of interest.

This quantitative study used secondary data from Demographic and Health Surveys (DHS) Program collected from four southern African countries namely Angola, Namibia, Zambia, and Zimbabwe. The data were primarily collected for the 2011 Angola malaria indicator survey, 2010 – 2011 Zimbabwe demographic and health survey, 2013 Namibia demographic health survey, and 2013 – 2014 Zambia demographic and health survey. The main objective of the Angola malaria indicator survey was to provide specific malaria indicators (Cosep Consultoria, Consaúde, & ICF International, 2011) while that of the demographic health surveys was to provide updated estimates of basic demographic and health indicators (Central Statistical Office et al., 2015; Ministry of Health and Social Services & Namibia Statistics Agency, 2014; Zimbabwe National Statistics Agency (ZIMSTAT) & ICF International, 2012). In all countries, the data were collected nationwide, covering all regions in both urban and rural areas.

In Angola, four regional domains namely hyperendemic region, mesoendemic stable region, mesoendemic unstable region, and Luanda province were identified. In each domain 60 clusters were selected with a total of 96 urban clusters and 144 rural clusters. Clusters were selected in three stages using a stratified design. In first stage communes in each province were stratified as urban or rural and then selected with a probability proportional to each domain's population size. In second stage clusters were selected with a probability proportional to the selected communes' size while in the third stage about equal number of households from each cluster's household listing was selected to be interviewed. In total, 8,806 households were selected of which 8,030 were interviewed. In each selected household, all women aged 15 to 49 years were selected for personal interview and all children aged 6 to 59 months were selected for malaria and anemia testing. Field work started in January 2011 and ended in May 2011 (Cosep Consultoria, Consaúde, & ICF International, 2011).

In Namibia, clusters were selected in two stages using a stratified design whereby two strata, one rural and one urban, were identified per each of the 13 regions resulting in 13 rural and 13 urban strata. In first stage, using the preliminary frame of the 2011 Namibia population and housing survey, 269 urban and 285 rural enumeration areas were selected from the sampling frame using a stratified probability proportional to the number of households in the enumeration area. From each enumeration area, a predetermined number of samples were selected independently in every stratum and a complete household listing and mapping in all selected clusters was obtained. In the second stage, an equal probability systematic sampling was used to select a fixed number of 20 households from every rural and urban cluster. In total, 11,004 households were selected of which 9,849 were interviewed. Field work started in May 2013 and ended in September 2013 (Ministry of Health and Social Services & Namibia Statistics Agency, 2014).

In Zambia, clusters were selected in two stages using a stratified design whereby two strata, one rural and one urban, were identified per each of the 10 provinces resulting in 10 rural and 10 urban strata. In first stage, using a sampling frame from the 2010 population and housing census, 305 urban and 417 rural enumeration areas were selected from the sampling frame using a stratified probability proportional to the number of households in the enumeration area. In the second stage, geographic coordinates for each sampled cluster were recorded using Global Positioning System receivers and a complete list and map of all private households was obtained and used to select an average of 25 households from each enumeration area. In total, 18,052 households were selected of which 15,920 were interviewed. All women aged from 15 to 49 and all men aged from 15 to 59 who were present in the selected households the night before the survey were eligible for inclusion in the survey. Field work started in August 2013 and ended in April 2014 (Central Statistical Office et al., 2015).

In Zimbabwe, the 2002 population census enumeration areas constituted a sampling frame and clusters were selected in two stages using a stratified design whereby two strata, one rural and one urban, were identified. In first stage, 169 urban and 237 rural enumeration areas were selected from the sampling frame. In the second stage, a complete list and map of all private households was obtained and used to select a representative sample of households. In total, 10,828 households were selected of which 9,756 were interviewed. All women aged from 15 to 49 and all men aged from 15 to 59 who were present in the selected households the night before the survey were eligible for inclusion in the survey. Field work started in September 2010 and ended in March 2011 (Zimbabwe National Statistics Agency (ZIMSTAT) & ICF International, 2012).

The required sample size for this research was determined using a freely online accessible software G*Power 3.0.10. After selecting the appropriate test family, statistical test, and type of power analysis, one has to determine the effect size, alpha, power, and the degree of freedom. For this study the test family was $x^2$ *tests*, the statistical test was *goodness-of-fit tests: Contingency tables*, and the types of power analysis was *A priori: Compute required sample size – given α, power, and effect size*. G*Power gives three options about the effect size: small (0.1), medium (0.3), and large (0.5). Large effect can be easily identified even with a small sample size whereas small effect is not only difficult to identify but could also be of little scientific importance (Suresh & Chandrashekara, 2012).

However, considering the seriousness of malaria and its impact on the population, the effect size was set to small. If a small effect cannot be detected, then this would be close to there being no effect at all, unlike when failure to detect larger effect would not exclude the possibility of there being a smaller effect. Alfa and power were set at .5 and .95 respectively. Type I error was less likely as the effect in malaria prevention exists when mosquito nets are used (Selemani et al., 2016), or indoors are sprayed (Steinhardt et al., 2013) or a combination of both mosquito nets and indoor residual spraying (West et al., 2015). In such a case, the power could be set higher to minimize the chances of the only highly possible type II error (Ellis, 2010). The degree of freedom was computed using the formula *df = number of columns – 1 multiplied by the number of rows – 1* (Frankfort-Nachmias & Nachmias, 2008). There are three columns and two rows and thus *df = 2*. Using these data G*Power calculated a total sample size of 1,545. There were 43,555 households interviewed in the selected four countries.

**Archival Data**

In all the four countries, Angola, Namibia, Zambia, and Zimbabwe, clusters or enumeration areas were identified and classified as either rural or urban and households selected for interview using a multi-stage stratified design. In total, there were 1,083 rural and 839 urban enumeration areas with 43,555 households interviewed. In each household, all women aged 15 to 49 and all men aged from 15 to 59 were interviewed and altogether there were 30,407 respondents about whether their children had fever in two weeks period that preceded data collection. The details of number of enumeration areas and interviewed households per country are provided in Table 2.

*Table 2: Number of Enumeration Areas and Interviewed Households*

| Country | Cluster/Enumeration Areas | | Interviewed Households | Interviewed about fever in last two weeks |
|---|---|---|---|---|
| | Rural | Urban | | |
| Angola | 144 | 96 | 8030 | 7714 |
| Namibia | 285 | 269 | 9849 | 4803 |
| Zambia | 417 | 305 | 15920 | 12689 |
| Zimbabwe | 237 | 169 | 9756 | 5201 |
| Total | 1083 | 839 | 43555 | 30407 |

Secondary data from Demographic and Health Surveys database were used. This database stores and provides on request data from nationally-representative household surveys from several countries in areas such as population, health, and nutrition (Demographic and Health Surveys Program, n.d.). To have access to and use data from this database, one needs to register online with the Demographic and Health Surveys Program. The registration process requires providing information such as researcher's names, address, associated institution, and personal contact numbers as well as the title, purpose, and brief description of the study for which data are being requested. Access and permission to access the needed data from the four countries, namely Angola, Namibia, Zambia, and Zimbabwe, of which data are available in English was granted on November 23, 2015. The authorization letter is included in Appendix A.

**Instrumentation and Operationalization of Constructs**

Data from 2011 Angola malaria indicator survey, 2010 – 2011 Zimbabwe demographic and health survey, 2013 Namibia demographic health survey, and 2013 – 2014 Zambia demographic and health survey would be merged. These data are provided, on request, free of charge by the Demographic and Health Survey Program. The original datasets consist of 43,555 interviewed households. These datasets were filtered using as inclusion criteria the availability of information on final result of malaria from blood smear test. This left a sample size of 3431 respondents.

In one group of dataset, the number of variables varied from 317 for Angola to 455 for Namibia while in the other group, variables varied from 967 for Zimbabwe to 1507 for Angola. However, only seven variables were relevant for this study. Table 3 shows the variable names, labels, measurement scale, value, and value definition as per original datasets.

*Table 3: Variable Names, Labels, Measurement Scale, Value, and Value Definition*

| Name | Label | Level of Measurement | Value | Definition |
|---|---|---|---|---|
| HV228 | Children under 5 slept under mosquito bed net last night | Nominal | 0<br>1<br>2<br>3 | No<br>All children<br>Some children<br>No net in household |
| HV253 | Has dwelling been sprayed against mosquitoes in last 12 months | Nominal | 0<br>1<br>8 | No<br>Yes<br>Do not know |
| HV009 | Number of household members | Continuous | | |
| HV106 | Highest educational level attained | Ordinal | 0<br>1<br>2<br>3<br>8 | No education, pre-school<br>Primary<br>Secondary<br>Higher<br>Do not know |
| HV270 | Wealth index | Ordinal | 1<br>2<br>3<br>4<br>5 | Poorest<br>Poorer<br>Middle<br>Richer<br>Richest |
| HV025 | Type of place of residence | Nominal | 1<br>2 | Urban<br>Rural |
| HML32 | Final result of malaria from blood smear test | Nominal | 0<br>1 | Negative<br>Positive |

## Data Analysis Plan

The Statistical Program for the Social Sciences (SPSS) version 24, a statistical application developed by IBM, was used to analyze the study data. This application was chosen because the researcher is proficiently comfortable using it and it has the capabilities to run the inferential statistical analyses required to answer the research questions. Data used in this study were gathered from the Demographics and Health Surveys Program. The data came from four different countries and were collected at different times. Thus, the data were cleaned in order to identify and appropriately code variable measurement scales or deal with missing data. For each country, the needed data were found in two different files with varied number of records and variables as shown in Table 4.

*Table 4: Data File Name, Records, and Variables per Country*

| Country | Data File Name | Number of Records | Number of Variables |
|---|---|---|---|
| Angola | AOBR61FL.SAV | 22925 | 317 |
| | AOPR61FL.SAV | 40600 | 239 |
| Namibia | NMBR61FL.SAV | 18090 | 983 |
| | NMPR61FL.SAV | 41646 | 455 |
| Zambia | ZMBR61FL.SAV | 49207 | 999 |
| | ZMPR61FL.SAV | 83058 | 379 |
| Zimbabwe | ZWBR62FL.SAV | 19279 | 967 |
| | ZWPR62FL.SAV | 41946 | 329 |

For the purpose of this study, only the variables of interest were selected by deleting the other variables, and saved in a different folder, in case reference to original folder would be needed. Thereafter, one of the variables' names which was different from similar variables in other datasets was redefined before the data were merged. The new dataset was saved as ALLMERGE.SAV with only seven variables. Table 5 shows the old and new names of the variables together with the variable label and analysis tests.

Missing values are expected when secondary data are used (Cheng & Phillips, 2014). Cases with missing values can be deleted from dataset either listwise or pairwise (Field, 2013) or can be are handled by multiple imputation whereby values of the missing data are estimated using statistical model before analysis (Sullivan, Salter, Ryan, & Lee, 2015). Considering that the available sample size, 3431, was larger than the required sample, 1,545, cases with missing values were deleted listwise and the sample remained large enough.

The following are the research questions and hypotheses for this study:

*RQ 1*: What is the relationship between the use of mosquito bednet and contracting malaria?

$H_0 1$: There is no association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do not report lower malaria prevalence than non-users.

$H_a 1$: There is an association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do report lower malaria prevalence than non-users.

*Table 5: Old and New Names, Variable Label, and Analysis Tests*

| Old Name | New Name | Variable Label | Analysis |
|---|---|---|---|
| HV009 | MEMBERS | Number of household members | Logistic regression and Odds ratio |
| HV025 | PLACE | Type of place of residence | Chi-square, Loglinear analysis, Odds ratio |
| HV106 | EDULEVEL | Highest educational level attained | Logistic regression, Odds ratio |
| HV228 | NETUSE | Children under 5 slept under mosquito bed net last night | Chi-square, Logistic regression, Loglinear analysis, and Odds ratio |
| HV253, SH109 | SPRAYED | Has dwelling been sprayed against mosquitoes in last 12 months | Chi-square, Logistic regression, Loglinear analysis, and Odds ratio |
| HV270 | WEALTH | Wealth index | Logistic regression and Odds ratio |
| HML32 | MALARIA | Final result of malaria from blood smear test | Chi-square, Logistic regression, Loglinear analysis, and Odds ratio |

*RQ 2*: What is the relationship between the use indoor residual spraying and contracting malaria?

$H_02$: There is no association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do not report lower malaria prevalence than non-users.

$H_a2$: There is an association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do report lower malaria prevalence than non-users.

*RQ 3*: What is the relationship between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods?

$H_03$: There is no association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are similar among those who use both, either, or neither of the malaria prevention methods.

$H_a3$: There is an association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are different among those who use both, either, or neither of the malaria prevention methods.

Summary statistics were computed for the variables being analyzed. Considering that the intention was to identify the association or relationship between variables in order to refute or validate the research hypotheses, Chi-square was used with cross-tabulation to test the association between the independent variable use of bednet in *RQ 1* and the use of indoor residual spraying in *RQ 2* and the dependent variable reporting fever in the previous two weeks. The logistic regression tested the predictive effect of the independent variables on the dependent variable(s). To facilitate the interpretation of the logistic regression values, odds ratio were computed. The multinomial logistic regression allowed testing the association between three or more variables. All statistical tests were conducted at 5% significance level, 95% Confidence Interval, and a *p*- value of .05.

## Threats to Validity

Validity refers to whether a particular procedure used in a study measures what it is supposed to measure (Forthofer, Lee, & Hernandez, 2007). Internal validity is concerned with establishing causation while external validity has to do with generalization (Frankfort-Nachmias & Nachmias, 2008). This study was not about establishing a causal relationship, thus threats to internal validity might not have been an issue. Furthermore, external validity might not be an issue either considering that the study was cross sectional and therefore the researcher aimed at providing a correlational and predictive relationship among variables. In this study there were no related survey instruments as secondary data was used. Construct validity was therefore established through hypothesis testing. However, threats to validity include human error that might have existed during the capture and recording of results and demographic and other information. There is also the possibility of information bias.

## Ethical Procedures

Secondary data from Demographic and Health Surveys Program were used for this study. Although the datasets were publicly available, registration had to be made on the program's website and full name, associated institution, address, and contact details as well as the proposed research title, purpose, and a brief description of the study were provided. An assurance that the data will not be used for purpose other than the one stated and that the data will not be shared with other researchers without prior authorization had to be guaranteed. A written authorization to use the requested dataset was given on November 23, 2015. The authorization letter is included in Appendix A. The data sets did not contain any identifier of study subjects.

A study proposal was submitted to and approved by the Institutional Review Board at Walden University.

## Summary

This study is a cross-sectional quantitative study that used secondary data from Demographic and Health Surveys Program. The relationship between the study variables was measured and analyzed without manipulating the study environment and thus a cross-sectional design was considered appropriate for this study. A correlational and predictive relationship was studied among the variables. The independent variable in this study was the use of recommended malaria prevention methods namely bednets and indoor residual spraying while the dependent variable was malaria status. Furthermore, some characteristics such as place of residence, economic status, level of education, and number of household members were used as independent variables and the use of malaria prevention method as the dependent variable. The measurement scales were nominal and ordinal. The target population for this study comprised of all households in four southern African countries namely Angola, Namibia, Zambia, and Zimbabwe. The datasets were filtered using as inclusion criteria the availability of information on final result of malaria from blood smear test. The researcher computed summary statistics including frequencies and conducted statistical tests at 5% significance level, 95% Confidence Interval, and a *p*-value of .05. Threats to validity were mitigated through the use of methods such as case deleting and data transformation where appropriate. Statistical results of the study are presented in Chapter 4.

# Chapter 4: Results

The purpose of this quantitative study was to compare the effectiveness of the use of mosquito bednets and indoor residual spraying in the prevention of malaria and to identify the sociodemographic and socioeconomic characteristics of people who use both methods, either, or neither method. The research questions and hypotheses were:

*RQ 1*: What is the relationship between the use of mosquito bednet and contracting malaria?

$H_0 1$: There is no association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do not report lower malaria prevalence than non-users.

$H_a 1$: There is an association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do report lower malaria prevalence than non-users.

*RQ 2*: What is the relationship between the use indoor residual spraying and contracting malaria?

$H_0 2$: There is no association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do not report lower malaria prevalence than non-users.

$H_a 2$: There is an association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do report lower malaria prevalence than non-users.

*RQ 3*: What is the relationship between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods?

$H_0 3$: There is no association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are similar among those who use both, either, or neither of the malaria prevention methods.

$H_a 3$: There is an association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are different among those who use both, either, or neither of the malaria prevention methods.

In this Chapter the researcher will describe how the data were collected, present the results, and thereafter, a summary and a transition to the next chapter.

## Data Collection

The data collection was as planned in Chapter 3. Secondary data from 2011 Angola malaria indicator survey, 2010 – 2011 Zimbabwe demographic and health survey, 2013 Namibia demographic health survey, and 2013 – 2014 Zambia demographic and health survey were requested from the Demographic and Health Surveys database. To have access to and use data from this database, the researcher had first to register online with the Demographic and Health Surveys Program by providing information such as researcher's names, address, associated institution, and personal contact numbers as well as the title, purpose, and brief description of the study for which data are being requested. Access and permission to access the needed data from the four countries, namely Angola, Namibia, Zambia, and Zimbabwe, of which data are available in English was granted on November 23, 2015. The authorization letter is included in Appendix A.

For the original data, there were a total of 1,083 rural and 839 urban enumeration areas with 43,555 households interviewed. In each household, all women aged 15 to 49 and all men aged from 15 to 59 were interviewed and altogether there were 30,407 respondents about whether their children had fever in two weeks period that preceded data collection. These data were collected at different periods but they were however the latest available for the respective countries at the time of proposal writing. Data were cleaned accordingly to answer a specific question. To answer the *RQ 1* all cases for variable *HML32*, *final result of malaria from blood smear test* and *HML35, result for malaria paracheck test (rapid test)* with values other than *0 = Negative* or *1 = Positive* as well as all cases for variable *HV228, children under 5 slept under bednet last night*, with values other than *0 = No* or *1 = All children* were deleted. Furthermore all cases for variable *SH109A, someone sprayed interior walls* with values other than *0 = No* were deleted. This deletion resulted in a sample size of 909 subjects, which is still good enough to run statistical tests since G*Power 3.0.10 estimates a sample size of 903 at an effect size of .12 with a degree of freedom equal to 1. When assessing for confounders in the logistic regression, variable *HV106, NA – Highest educational level*, had 11.3% missing data and was entirely excluded from analysis. Variable *HV009*, *Number of* *household members*, was recoded to variable *HV009CAT*, *Number of household members CAT*, with categories *1 = Low* for household with 2 to 4 members, *2 = Medium* for households with 5 to 7 members, and *3 = High* for households with 8 or more members.

To answer the *RQ 2* variable  all cases for variable *SH109A*, *Someone sprayed interior walls*,  with values other than *0 = No* or *1 =* Yes were deleted while all cases with values other than *3 = No bednet in household* for variable *HV228*, *children under 5 slept under bednet last night*, were deleted. When assessing for confounders in the logistic regression, variable *HV106*, *NA – Highest educational level*, had about 18% missing data and was entirely excluded from analysis. Variable *HV009*, *Number of household members*, was recoded as for *RQ 1*.

To answer the *RQ 3* variable *HV228*, *Children under 5 slept under bednet last night*, was recoded into a different variable *HV228Rec*, *Children under 5 slept under net No or All*, by recoding the data into *0 = No*, including the cases for *3 = no bednet in household*, and *1 = Yes* then sorting cases and deleting all cases with no value for this variable. Furthermore, for variable *SH109A*, *Someone sprayed interior walls*, all cases with no values or values other than *0 = No* and *1 = Yes* were deleted. Thereafter, a new variable *PREVMETH*, *Malaria prevention method used*, was created with values *0 = None* for no bednet nor spraying used, *1 = Net only* for bednet but no spraying used, *2 = Spray only* for no bednet but spraying used, and *3 = Both net and spray* for both bednet and spraying used. Variable *HV009*, *Number of household members*, was recoded as for *RQ 1* while cases with *DK* or missing values for any variable were deleted.

**Data Exclusion**

For Angola, blood samples were tested by rapid diagnostic testing and thick film blood smears testing (Cosep Consultoria, Consaúde, & ICF International, 2011) to rule out malaria whereby in the other three countries malaria was ruled out based on the presence or absence of fever. For this reason, data from the other three countries were entirely removed from the analysis. Furthermore, to answer *RQ 1*, cases with values other than *0 = No* or *1 = Yes* or *1 = All children* accordingly for the dependent and independent variables were removed from analysis leaving a sample size of 909 subjects. To answer *RQ 2*, cases with values other than *0 = No* or *1 = Yes* for the dependent and independent variables and cases with values other than *0 = No* for variable *HV228* were removed from analysis leaving a sample size of 2272 subjects.

## Data Analysis Results

*RQ 1*: What is the relationship between the use of mosquito bednet and contracting malaria?

$H_0 1$: There is no association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do not report lower malaria prevalence than non-users.

$H_a 1$: There is an association between the use of mosquito bednet and contracting malaria. In other words, in southern Africa, users of mosquito bednet do report lower malaria prevalence than non-users.

The sample comprised of under-fives whose malaria blood test results were available. There was no specification of particular subjects' age or sex. A chi-square test for association between children sleeping under a mosquito bednet and final result of malaria from blood smear test was performed using a sample size of *n* = 909. No cell had expected count less than 5. As shown in Table 6, there was no statistically significant association between children sleeping under a mosquito bednet and final result of malaria from blood smear test, $x^2$ (1) = 3.324, *p* = .068, odds = .613, 95% CI [.361, 1.042]. The measure of effect between children sleeping under a mosquito bednet and final result of malaria from blood smear test further shows the lack of statistically significant association, *V* = .060, *p* = .068.

As shown in Figure 1, 331 children did not sleep under mosquito bednet while 578 did sleep under mosquito bednet the night prior to data collection. From those who did not sleep under a mosquito bednet 28 (9.2%) had malaria positive blood result compared to 31 (5.7%) from those who slept under bednet, a difference of 3.5%.

*Table 6: Chi-Square Results for Sleeping under Mosquito Net and Final Malaria Result*

| | Value | *P* | 95%CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Pearson $x^2$ | 3.342 | .068 | | |
| Df | 1 | | | |
| *V* | .060 | .068 | | |
| Odds Ratio | .613 | | .361 | 1.042 |

The results in Table 6 and Figure 1 supported the null hypothesis that there is no association between the use of bednet and contracting malaria. In other words, in southern Africa, users of bednet do not report lower malaria prevalence than non-users.

As result, we fail to reject the null hypothesis. Considering that these results are contradicting with a number of other research findings, a regression test was conducted to control for confounding factors such as areas of residence, wealth index, level of education, and number of household members.

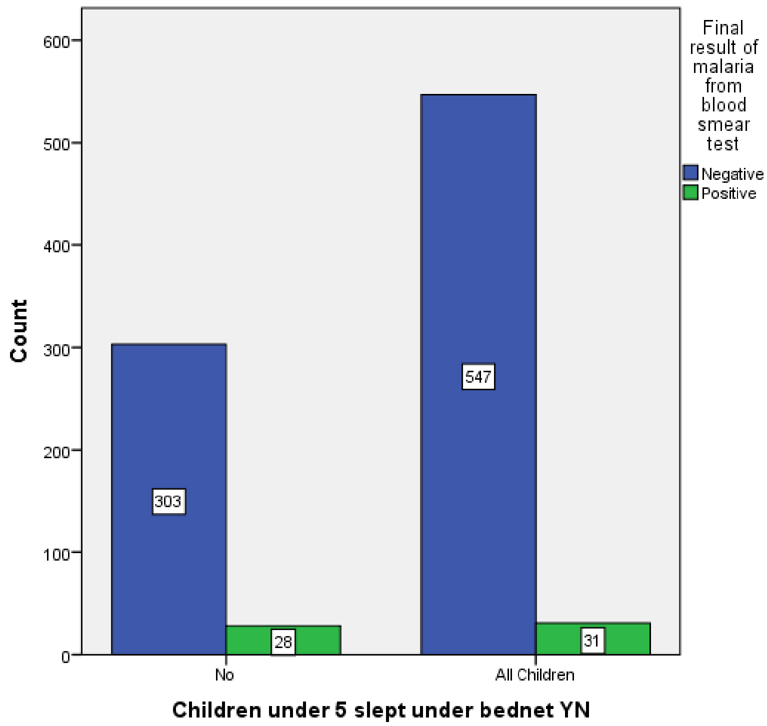


*Figure 1: Relationship between Sleeping under Bednet and Having Malaria*

The first model in the logistic regression included variable *HV228YN*, *Children under 5 slept under bednet last night Yes No*, as a predictor. This model was not statistically significant, $x^2(1) = 0.322$, $p = .073$. The model could explain 0.9% (Nagelkerke $R^2$) of the variances, in having malaria. Overall, the model could correctly classify 93.5% of cases. As shown in Table 7, the Wald statistics, Wald = .327, $p = .071$, also support these results showing that sleeping under a mosquito bednet the previous night does not predict having malaria.

*Table 7: Predicting Malaria based on Bednet Use*

| | B | S.E. | Wald | Df | Sig. | Exp(B) | 95% C.I. for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Slept under bednet last night Yes No(1) | -.486 | .270 | .327 | 1 | .071 | .613 | .361 | 1.042 |
| Constant | -2.382 | .198 | 145.373 | 1 | .000 | .092 | | |

The second model, which included variable *HV025, Types of place of residence,* as predictor was statistically significant, $x^2(2) = 48.153$, $p$ = <.001. The model could explain 13.5% (Nagelkerke $R^2$) of the variances in having malaria. Overall, the model could correctly classify 93.5% of cases. As shown in Table 8, the Wald statistics, Wald = 20.701, $p$ = <.001, also support these results showing that the place of residence does predict having malaria.

*Table 8: Predicting Malaria based on Place of Residence*

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I.for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Place of residence(1) | 2.716 | .597 | 20.701 | 1 | .000 | 15.126 | 4.694 | 48.744 |
| Constant | -4.531 | .596 | 57.816 | 1 | .000 | .011 | | |

The third model, which included variable *HV270, wealth index,* as predictor, was statistically significant, $x^2(6) = 68.708$, $p$ = <.001. The model could explain 19.1% (Nagelkerke $R^2$) of the variances in having malaria. Overall, the model could correctly classify 93.5% of cases. As shown in Table 9, the Wald statistics of some categories in the wealth index does not predict reporting having malaria while others do.

*Table 9: Predicting Malaria based on Wealth Index and Bednet Use*

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I. for Exp(B) Lower | Upper |
|---|---|---|---|---|---|---|---|---|
| Place of residence(1) | 2.221 | .620 | 12.818 | 1 | .000 | 9.219 | 2.733 | 31.101 |
| Wealth index | | | 17.264 | 4 | .002 | | | |
| Wealth index(1) | -.576 | .453 | 1.617 | 1 | .203 | .562 | .232 | 1.365 |
| Wealth index(2) | -.082 | .388 | .045 | 1 | .832 | .921 | .431 | 1.969 |
| Wealth index(3) | -1.111 | .457 | 5.896 | 1 | .015 | .329 | .134 | .807 |
| Wealth index(4) | -1.869 | .551 | 11.526 | 1 | .001 | .154 | .052 | .454 |
| Constant | -3.510 | .700 | 25.180 | 1 | .000 | .030 | | |

The fourth model included variable *HV009CAT, Number of households members CAT*. Although the model was statistically significant, $x^2(8) = 73.170$, $p$ = <.001, adding this variable to the model had no significant effect, $x^2(2) = 4.462$, $p = .107$. The model could explain 20.3% (Nagelkerke $R^2$) of the variances in having malaria. Overall, the model could correctly classify 93.5% of cases. As shown in Table 10, the Wald statistics of different categories also supported these results showing that the number of household members does not predict having malaria. However, this model indicates that the odds of a person living in rural area having malaria are 9.49 times higher than a person living in urban area.

*Table 10: Predicting Malaria based on Number of Household Members, Wealth Index, and Bednet Use*

| | | | | | | | 95% C.I. for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | S.E. | Wald | df | Sig. | Exp(B) | Lower | Upper |
| Place of residence(1) | 2.250 | .621 | 13.114 | 1 | .000 | 9.486 | 2.807 | 32.057 |
| Wealth index | | | 18.410 | 4 | .001 | | | |
| Wealth index(1) | -.586 | .459 | 1.634 | 1 | .201 | .556 | .226 | 1.367 |
| Wealth index(2) | -.090 | .393 | .052 | 1 | .820 | .914 | .423 | 1.975 |
| Wealth index(3) | -1.098 | .460 | 5.707 | 1 | .017 | .334 | .136 | .821 |
| Wealth index(4) | -1.989 | .556 | 12.811 | 1 | .000 | .137 | .046 | .407 |
| Number of household members CAT | | | 4.048 | 2 | .132 | | | |
| Number of household members CAT(1) | .707 | .375 | 3.554 | 1 | .059 | 2.028 | .972 | 4.231 |
| Number of household members CAT(2) | .777 | .446 | 3.041 | 1 | .081 | 2.175 | .908 | 5.208 |
| Constant | -4.159 | .777 | 28.618 | 1 | .000 | .016 | | |

These logistic regression results indicate that the type of place of residence and being in the richer or richest wealth index categories are the only significant confounders. When these confounding variables were analyzed together with the predictor variable Children under five slept under bednet last night Yes No, adding interaction terms such as using a mosquito bednet by type of place of residence, using a mosquito bednet by wealth index, or using a mosquito bednet by place of residence by wealth index had no significant effect to the models.

*RQ 2*: What is the relationship between the use indoor residual spraying and contracting malaria?

$H_0 2$: There is no association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do not report lower malaria prevalence than non-users.

$H_a 2$: There is an association between the use of indoor residual spraying and contracting malaria. In other words, in southern Africa, users of indoor residual spraying do report lower malaria prevalence than non-users.

The sample comprised of under-five children. There was no specific age or sex for subjects. A chi-square test for association between the use of indoor residual spraying and having malaria was performed using a sample size of $n$ = 2272. No cell had expected count less than 5. As shown in Table 11, there was a statistically significant association between the use of indoor residual spraying and having malaria, $x^2$ (1) = 5.152, $p$ = .023, odds = 2.382, 95% CI [1.100, 5.158]. The measure of effect between the use of indoor residual spraying and having malaria shows the presence of statistically significant association, $V$ = .048, $p$ = .023. Furthermore, as shown in Figure 2, 2139 children lived in dwellings that were not sprayed against mosquitoes while 133 children lived in sprayed dwellings. From those who lived in non-sprayed dwellings, 250 (13.2%) had malaria compared to 7 (5.6%) from those who lived in sprayed dwellings.

*Table 11: Chi-Square Results for Using Indoor Residual Spraying and Having Malaria*

| | Value | *P* | 95% CI | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Pearson $x^2$ | 5.152 | .023 | | |
| Df | 1 | | | |
| *V* | .048 | .023 | | |
| Odds Ratio | 2.382 | | 1.100 | 5.158 |

The results in Table 11 and Figure 2 supported the alternative hypothesis that there is an association between the use of indoor residual spraying and having malaria. In other words, in southern Africa, users of indoor residual spraying do report lower malaria prevalence than non-users. As result, we rejected the null hypothesis. As for Research Question 1, a regression test was conducted to control for confounding factors such as area of residence, wealth index, and number of household members.

The first model in the logistic regression included variable *SH109A*, *Someone sprayed interior walls*, as a predictor. This model was statistically significant, $x^2$ (1) = 6.213, $p$ = .013. The model could explain 0.5% of the variances (Nagelkerke $R^2$) in having malaria. Overall, the model could correctly classify 88.7% of cases. As shown in Table 12, the Wald statistics, Wald = 4.851, $p$ = .028, also support these results showing that living in a dwelling that was sprayed predicted having malaria.

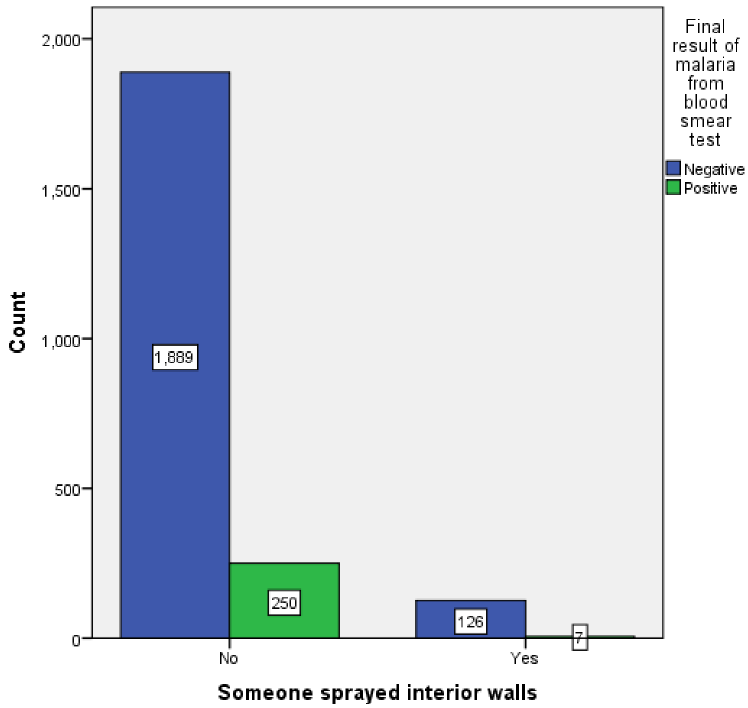


*Figure 2: Relationship between Sprayed Dwelling and Having Malaria*

*Table 12: Predicting Malaria based on Living in a Sprayed Dwelling*

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I. for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | Lower | Upper |
| Dwelling sprayed (1) | -.868 | .394 | 4.851 | 1 | .028 | .420 | .194 | .909 |
| Constant | -2.022 | .067 | 902.964 | 1 | .000 | .132 | | |

Variable *HV025, Type of place of residence* was added as predictor in the second model. This model was statistically significant, $x^2$ (2) = 120.072, *p* = <.001. The model could explain 10.2% (Nagelkerke $R^2$) of the variances in having malaria. Overall, the model could correctly classify 88.7% of cases. However, as shown in Table 13, only the Wald statistic for the place of residence variable remained statistically significant.

*Table 13: Predicting Malaria based on Place of Residence and Sprayed Dwelling*

| | | | | | | | 95% C.I. for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | S.E. | Wald | df | Sig. | Exp(B) | Lower | Upper |
| Dwelling sprayed (1) | -.729 | .400 | 3.331 | 1 | .068 | .482 | .220 | 1.055 |
| Type of place of residence(1) | 2.158 | .270 | 63.775 | 1 | .000 | 8.656 | 5.096 | 14.700 |
| Constant | -3.815 | .261 | 212.913 | 1 | .000 | .022 | | |

Variable *HV270, Wealth index* was added as predictor in the third model. This model was statistically significant, $x^2$ (6) = 142.772, $p$ = <.001. The model could explain 12% (Nagelkerke $R^2$) of the variances in having malaria. Overall, the model could correctly classify 88.7% of cases. However, as shown in Table 14, the Wald statistics for the different categories of wealth index were not statistically significant. This indicates that wealth index is not a statistically significant predictor of having malaria.

Variable *HV009, Number of household members* was added as predictor in the fourth model. Although this model was statistically significant, $x^2$ (8) = 143.772, $p$ = <.001 adding this variable to the model did not make significant contribution, $x^2$ (2) = .679, $p$ = .712. The model could explain 12.1% (Nagelkerke $R^2$) of the variances in having malaria. Overall, the model could correctly classify 88.7% of cases. Furthermore, as shown in Table 15, the Wald statistics for the different categories in number of household members as well as the other predictors were not statistically significant. This indicates that the number of household members is not a statistically significant predictor of malaria.

*Table 14: Predicting Malaria based on Sprayed Dwelling and Wealth Index*

| | | | | | | | 95% C.I. for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | S.E. | Wald | df | Sig. | Exp(B) | Lower | Upper |
| Dwelling sprayed (1) | -.716 | .404 | 3.134 | 1 | .077 | .489 | .221 | 1.080 |
| Type of place of residence(1) | 1.829 | .289 | 40.046 | 1 | .000 | 6.227 | 3.534 | 10.972 |
| Wealth index | | | 22.011 | 4 | .000 | | | |
| Wealth index(1) | .570 | .186 | 9.400 | 1 | .002 | 1.769 | 1.228 | 2.547 |
| Wealth index(2) | .329 | .194 | 2.897 | 1 | .089 | 1.390 | .951 | 2.031 |
| Wealth index(3) | -.172 | .233 | .547 | 1 | .459 | .842 | .534 | 1.328 |
| Wealth index(4) | -.492 | .289 | 2.897 | 1 | .089 | .611 | .347 | 1.077 |
| Constant | -3.646 | .318 | 131.422 | 1 | .000 | .026 | | |

*Table 15: Predicting Malaria based on Place of Residence, Sprayed Dwelling, Wealth Index, and Number of Household Members*

| | B | S.E. | Wald | df | Sig. | Exp(B) | 95% C.I. for Exp(B) Lower | 95% C.I. for Exp(B) Upper |
|---|---|---|---|---|---|---|---|---|
| Dwelling sprayed (1) | -.703 | .405 | 3.021 | 1 | .082 | .495 | .224 | 1.094 |
| Type of place of residence(1) | 1.838 | .289 | 40.353 | 1 | .000 | 6.284 | 3.564 | 11.078 |
| Wealth index | | | 22.404 | 4 | .000 | | | |
| Wealth index(1) | .578 | .186 | 9.600 | 1 | .002 | 1.782 | 1.236 | 2.568 |
| Wealth index(2) | .328 | .195 | 2.839 | 1 | .092 | 1.388 | .948 | 2.034 |
| Wealth index(3) | -.174 | .234 | .557 | 1 | .456 | .840 | .531 | 1.328 |
| Wealth index(4) | -.502 | .291 | 2.971 | 1 | .085 | .605 | .342 | 1.071 |
| Number of household members CAT | | | .683 | 2 | .711 | | | |
| Number of household members CAT(1) | -.071 | .194 | .135 | 1 | .714 | .931 | .637 | 1.362 |
| Number of household members CAT(2) | -.138 | .169 | .663 | 1 | .415 | .871 | .625 | 1.214 |
| Constant | -3.568 | .338 | 111.531 | 1 | .000 | .028 | | |

These logistic regression results indicate that type of place of residence, as was in *RQ 1*, is the only significant confounder. When this confounding variable was analyzed together with the predictor variable *Dwelling sprayed*, the model was statistically significant, $x^2$ (3) = 120.337, $p$ = <.001. The model could explain 10.2% (Nagelkerke $R^2$) of the variances in having malaria. Overall, the model could correctly classify 88.7% of cases. As shown in Table 16, this model indicated that only the type of place of residence, Wald = 61.432, *p* = <.001, odds = 8.927, 95% CI [.5.164, 15.432], could predict having malaria. The odds of a person living in rural area having malaria are 8.93 times higher than a person living in urban area.

*Table 16: Predicting Malaria based on Dwelling Sprayed and Place of Residence*

| | | | | | | | 95% C.I. for Exp(B) | |
|---|---|---|---|---|---|---|---|---|
| | B | S.E. | Wald | df | Sig. | Exp(B) | Lower | Upper |
| Type of place of residence (1) | 2.189 | .279 | 61.432 | 1 | .000 | 8.927 | 5.164 | 15.432 |
| Dwelling sprayed (1) | -.181 | 1.044 | .030 | 1 | .862 | .834 | .108 | 6.461 |
| Type of place of residence(1) by Dwelling sprayed (1) | -.620 | 1.130 | .301 | 1 | .583 | .538 | .059 | 4.925 |
| Constant | -3.844 | .270 | 202.538 | 1 | .000 | .021 | | |

*RQ 3*: What is the relationship between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods?

*$H_0 3$*: There is no association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are similar among those who use both, either, or neither of the malaria prevention methods.

*$H_a3$*: There is an association between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods. In other words, in southern Africa, the sociodemographic and socioeconomic characteristics are different among those who use both, either, or neither of the malaria prevention methods.

To determine whether factors such as place of residence, wealth index, the highest level of education attained, and number of members in the household have an association with the use of both, either, or neither of the malaria prevention methods, a multinomial logistic regression test was performed with the type of malaria prevention method used as dependent variable and place of residence, wealth index, the highest level of education attained, and number of members in the household as independent variables. The results for the multinomial logistic regression test are presented in Table 17.

The place of residence significantly predicted the use of mosquito bednet or not, $b = -0.345$, Wald $x^2$ (1) = 6.892, $p = .009$. The odds of those living in rural area to use a mosquito bednet are 1.41 times more than those living in urban area, odds ratio = .708, 95% CI [.547, .916]. However residing in urban area did not significantly predict whether the household is sprayed only, $b = -0.301$, Wald $x^2$ (1) = 1.421, $p = .233$, odds ratio = 1.351, 95% CI [.824, 2.216].

*Table 177: Multinomial Logistic Regression Test Results*

| Prevention methods used | B | Std. Error | Wald | Df | Sig. | Exp (B) | 95% C.I. for EXP(B) Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|---|---|
| Bednet only | | | | | | | | |
| Intercept | -.037 | .422 | .008 | 1 | .930 | | | |
| Place of residence=1 | -.345 | .131 | 6.892 | 1 | .009 | .708 | .547 | .916 |
| Wealth index=1 | -1.692 | .224 | 56.930 | 1 | .000 | .184 | .119 | .286 |
| Wealth index=2 | -.752 | .194 | 15.100 | 1 | .000 | .471 | .323 | .689 |
| Wealth index=3 | -.555 | .172 | 10.378 | 1 | .001 | .574 | .409 | .805 |
| Wealth index=4 | -.026 | .137 | .036 | 1 | .849 | .974 | .746 | 1.273 |
| Educational level=0 | -1.601 | .428 | 13.981 | 1 | .000 | .202 | .087 | .467 |
| Educational level=1 | -1.191 | .407 | 8.561 | 1 | .003 | .304 | .137 | .675 |
| Educational level=2 | -.736 | .416 | 3.136 | 1 | .077 | .479 | .212 | 1.082 |
| H.hold members CAT=1 | 1.135 | .153 | 55.137 | 1 | .000 | 3.111 | 2.306 | 4.198 |
| H.hold members CAT=2 | .586 | .142 | 17.006 | 1 | .000 | 1.796 | 1.360 | 2.373 |
| Spray only | | | | | | | | |
| Intercept | -1.926 | .715 | 7.256 | 1 | .007 | | | |
| Place of residence=1 | .301 | .252 | 1.421 | 1 | .233 | 1.351 | .824 | 2.216 |
| Wealth index=1 | -3.173 | .756 | 17.620 | 1 | .000 | .042 | .010 | .184 |
| Wealth index=2 | -.854 | .372 | 5.267 | 1 | .022 | .426 | .205 | .883 |
| Wealth index=3 | -.108 | .288 | .140 | 1 | .708 | .898 | .510 | 1.579 |
| Wealth index=4 | -.460 | .273 | 2.828 | 1 | .093 | .632 | .370 | 1.079 |
| Educational level=0 | -.192 | .720 | .071 | 1 | .789 | .825 | .201 | 3.383 |
| Educational level=1 | -.814 | .680 | 1.432 | 1 | .231 | .443 | .117 | 1.681 |
| Educational level=2 | -.828 | .720 | 1.322 | 1 | .250 | .437 | .107 | 1.792 |
| H.hold members CAT=1 | -.048 | .311 | .024 | 1 | .877 | .953 | .519 | 1.752 |
| H.hold members CAT=2 | .285 | .237 | 1.438 | 1 | .231 | 1.329 | .835 | 2.116 |

Some of the categories of the wealth index significantly predicted the use of bednet only. The odds of a richest person using a mosquito bednet only are 5.43 times more than a poorest person, 2.12 times more than a poor person, and 1.74 times more than a middle person. However, there is no significant difference between the richest and the richer in using mosquito bednet only, *b* = - .026, Wald $x^2(1) = 0.036$, *p* = .849. Some categories of wealth index significantly predicted spraying only while other categories did not. The odds of a richest person using indoor residual spraying only is 23.81 times more than a poorest person and 2.35 times more than a poor person. The middle category, *b* = - .108, Wald $x^2$ (1) = 0.140, *p* = .708, and richer category, *b* = - .460, Wald $x^2$ (1) = 2.822, *p* = .093, did not significantly predict the use of indoor residual spraying only.

Having no education or primary education significantly predicted the use of bednet only. The odds of those with higher education using a mosquito bednet only were 4.95 times higher than those with no education, and 3.29 times higher than those with primary education. Having secondary education, *b* = - .736, Wald $x^2$ (1) = 3.136, *p* = .077, did not significantly predict the use of bednet only. There was no significant difference between having higher level of education and having no education, *b* = - .192, Wald $x^2$ (1) = 0.071, *p* = .789; having primary education, *b* = - .814, Wald $x^2$ (1) = 1.432, *p* = .231; or having secondary education, *b* = - .828, Wald $x^2$ (1) = 1.322, *p* = .250, on using indoor residual spraying only.

The number of household members significantly predicted the use of mosquito bednet only but not the use of indoor residual spray only. Households with low number of household members, *b* = 1.135, Wald $x^2$ (1) = 55.137, *p* = <.001, odds ratio = 3.111, 95%

CI [2.306, 4.198] and medium number household members, $b$ = 0.586, Wald $x^2$ (1) = 17.006, $p$ = <.001, odds ratio = 1.796, 95% CI [1.360, 2.373] are more likely to use mosquito bednets only than not using any method. There is no significant difference between households with high number of occupants and households with low number of occupants, $b$ = - .048, Wald $x^2$ (1) = 0.024, $p$ = .877, or households with medium number of occupants, $b$ = .285, Wald $x^2$ (1) = 1.438, $p$ = .231, on using indoor residual spray only.

The multinomial logistic regression test results indicate that there is a statistically significant association between place of residence and the use of mosquito bednet only but not spray only. Some categories of wealth index significantly predicted the use of bednet only as well as spraying only. While some categories of educational level did significantly predict the use of bednet only, educational level did not significantly predict spraying only. The number of household members significantly predicted the use of bednet only but did not significantly predict spraying only. There were no data on the use of both mosquito bednet and indoor residual spraying.

## Summary and Transition

In this chapter, results from the analysis of secondary data from the 2011 Angola malaria indicator survey were presented. Chi-square for association, logistic regression, and multinomial logistic regression tests were used to derive the following results: a) in RQ 1, there was no statistically significant association between the use of mosquito bednet and having malaria; b) in RQ 2, there was a statistically significant association between the use of indoor residual spraying and having malaria, and c) in RQ 3, there was a statistically significant association between some but not all of the sociodemographic and socioeconomic factors and the use of either or none of the malaria prevention methods.

The next and final chapter will cover the interpretation of the results, limitations of this study, recommendation for future study, and implications in terms of positive social change.

# Chapter 5: Discussion, Conclusions, and Recommendations

The purpose of this quantitative study was to compare the effectiveness of mosquito bednets and indoor residual spraying in the prevention of malaria and to identify the sociodemographic and socioeconomic characteristics of people who use both methods, either, or neither method. This study used secondary data from surveys conducted in one sub-Saharan country namely Angola. Sub-Saharan Africa seems to be the most malaria affected region with 89% of all malaria cases and 91% of all malaria deaths coming from this region (White et al., 2013; World Health Organization, 2015). While mosquito bednets and indoor residual spraying are some of the recommended malaria control methods in Africa, it remains unclear whether it would be more beneficial to use mosquito bednets and indoor residual spraying in combination or separately (World Health Organization, 2014). This study compared two malaria prevention methods, and it is hoped that it will guide public health officials and/or policy makers as well as potential users in making informed decision on which of the two approaches to take in the prevention of malaria. This study revealed the following results: a) in RQ 1, there was no statistically significant association between the use of mosquito bednet and having malaria; b) in RQ 2, there was a statistically significant association between the use of indoor residual spraying and having malaria, and c) in RQ 3, there was a statistically significant association between some but not all of the sociodemographic and socioeconomic factors and the use of either or none of the malaria prevention methods.

## Interpretation of Findings

The first study question, *RQ 1*, was: What is the relationship between the use of mosquito bednet and contracting malaria? Both the chi-square test for association and the logistic regression test revealed no statistically significant association between children sleeping under a mosquito bed net and the result of malaria from blood smear test. Other researchers have reported the lack of association in using mosquito bednets and reporting malaria. Quenneh (2016) found that the risk of contracting malaria is not less for children who own a mosquito bednet than those who do not. West et al. (2013) found a double mean malaria prevalence rate among those who used insecticide treated bednets alone compared to those who used both insecticide treated bednets and indoor residual spraying. Fullman et al. (2013) found a significant reduction in malaria among those who use both mosquito bednets and residual spraying compared to those who use bednets alone. However, Pinder et al. (2015) found no significant difference in clinical malaria among children who used mosquito bednets alone and those who combined indoor residual spraying and mosquito bednets. Furthermore, Lindblade et al. (2015) found a lower incidence of malaria infection among bednet users compared to non-users.

One factor that could have led to current findings could be the way the original variables were constructed. The independent variable was: Children under 5 slept under bednet last night; while the dependent variable was: Final result of malaria from blood smear test. The incubation period for malaria is 7 days or longer (Centers for Disease Control and Prevention, 2015; World Health Organization, 2018). It could be that a child did not sleep under a bednet last night but has been sleeping under one all the other previous nights, or slept under bednet only last night but not before. In the former, a child with malaria could be classified as non-user while they were using bednet at the time of infection. In the later situation, one could be classified as having fever in the last previous two weeks and as a bednet user while the infection happened before the person starts using a bednet.

Another factor could be the biting behavior of mosquitoes. Bednet could be protective for people who sleep under one but this protection is only limited to the sleeping time. It is a common practice to find people socializing whether inside or outside the house for some time in evening before going to bed and mosquito bites can happen during this time. Russell et al. (2016) found that 72% of mosquito bites on humans occurred in the outdoors while 76% of these bites occurred before 21h00 (9:00 PM). Some of the bites can even happen during broad daylight (Sougoufara et al., 2014). However, there seem to be no clarity on whether outdoor bites are associated with malaria transmission or not. Bradley et al. (2015) found no association between having malaria and outdoor mosquito bites while Degefa et al. (2017) concluded that the outdoor transmission level was considerably high.

The second study question, *RQ 2*, was: What is the relationship between the use of indoor residual spraying and contracting malaria? Both the chi-square test for association and the logistic regression test revealed a statistically significant association between children living in sprayed dwelling and having malaria. In a mathematical modeling study, indoor residual spraying alone was found to be up to ten times more effective than bednet use alone (Yakob, Dunning, and Yan, 2010). Other researchers have reported low malaria prevalence in sprayed compared to non-sprayed areas (Gimning et al., 2016; Kanyangarara et al. 2016; Raouf et al., 2017; Steinhardt et al., 2013; Sy et al., 2018). The low malaria prevalence rate in sprayed areas could be associated to the fact that the sprayed chemicals will remain effective for some period without the household occupants being required to do anything further. However, indoor residual spraying does not prevent mosquitoes from entering the sprayed house (Okumu et al., 2013) and eventually taking a bite, nor does it prevent the outdoor biting. This could explain the small though significant difference of malaria prevalence among those living in sprayed dwellings (5.6%) to those living in non-sprayed dwellings (13.2%).

The third study question, *RQ 3*, was: What is the relationship between sociodemographic and socioeconomic factors and the use of both, either, or neither of the malaria prevention methods? The multinomial logistic regression test results indicated that people living in rural area, richest or rich people, people with higher or secondary level of education, and households with lower or medium household members were more likely to use mosquito bednets only while only some wealth index categories namely poorest and poor significantly affected the use of residual indoor spraying only.

Other researchers have reported that the place of residence was a significant determinant on whether people use mosquito bednets or not (Ezire et al., 2015). Moon et al. (2016) and Ruyange et al. (2016) also reported that people with higher education and higher monthly income are more likely to use mosquito bednets. However, the findings of this study contradict those by Haileselassie and Ali (2018) who found that net usage was higher in urban area than rural area. The findings of this study also contradict the findings by Moon et al. (2016) that larger household sizes are more likely to use mosquito bednets.

Furthermore, Larsen, Borrill, Patel, and Fregosi (2017) also reported that richer people were less likely to have their households sprayed while Wadunde et al. (2018) reported the opposite. The findings of this study indicate that richest people are by far, 23.81 times, more likely than poorest people to have their houses sprayed. This could explain why other researchers found that richer people are less likely to get malaria (Kyu, Georgiades, Shannon, & Boyle, 2013; Njau, Stephenson, Menon, Kachur, & McFarland, 2013; Tusting et al., 2013; West et al., 2013) although De Castro and Fisher (2012) concluded that malaria could be the cause rather the consequence of poverty.

The discrepancy between the use of mosquito bednet and indoor residual spraying based on wealth index categories could be related to the cost associated with each of the two malaria prevention methods. The use of indoor residual spraying is three times more expensive than using mosquito bednets (White, Conteh, Cibulskis, & Ghani, 2011).

**Findings in Relation to Health Belief Model**

The researcher approached this study using the Health Belief Model (HBM). The basic components of the HBM, developed by social psychologists in public service in the 1950s to understand why people resisted participating in disease prevention and detection, are perceived threat, perceived benefits, perceived barriers, cues to action, self-efficacy, and other modifying variables (Champion & Skinner, 2008; Clemow, 2004). The main concepts in this research were the benefits addressed in Question 1 and 2, and the barriers and other modifying factors addressed in Question 3.

Benefits refer to the positive effect of taking action. For example if having malaria is so disturbing that one would be better off without it, then one is likely to take preventive measures. The opposite to this is perceived barriers where by negative consequences or the cost of a preventive action would prevent one from taking such action. The findings of this study indicate that indoor residual spraying is more effective in preventing malaria than using mosquito bednets. Thus, policy makers and consumers may find it justifiable to pay more in order to have households sprayed and reduce malaria cases. Furthermore, the findings in this study indicate that indoor residual spraying is determined by the wealth index. Considering that indoor residual spraying is three times more expensive than mosquito bednet (White, Conteh, Cibulskis, & Ghani, 2011), it may require more emphasis on the benefits, and possibly engaging in ways of making this malaria prevention method more affordable.

## Limitations of the Study

Since secondary data were used, limitations associated with the use of secondary data may apply to this study. For instance, three countries used fever as proxy for malaria yet fever can manifest in many other conditions other than malaria. Furthermore, some subjects had incomplete or missing data for the current study. Some data format, level of measurement, and labelling were different from what was suitable for this study. This required additional data manipulation which could lead to errors and therefore jeopardizing the validity of the study results. To mitigate this possibility of errors, the researcher dropped all cases from the three countries that used fever as proxy for malaria and crosschecked to ensure that all cases which used both methods or had missing or incomplete data were excluded from analysis. Excluding the three countries could have negatively affected data representativeness.

The data used in this study were collected in 2011. Although these were the latest available data, it could be that the current prevalence of malaria has varied during this time interval.

One of the variables was *Children under 5 slept under mosquito bed net last night*. The way this variable is constructed does not consider the fact that malaria incubation period goes up to 14 day, thus, possibility of misclassifying cases as bednet users where in fact the infection happened before they start using bednets or as non-bednet users while the infection happened when in fact they were using a bednet.

Although countries in sub-Sahara Africa may face similar problems related to malaria, this study and the data used were specific to southern Africa, and more specifically to Angola. Thus the results of this study may not be generalized to the entire sub-Saharan or African region.

## Recommendations

This study quantitatively compared the effectiveness of mosquito bednets and indoor residual spraying in the prevention of malaria and identified the sociodemographic and socioeconomic characteristics of people who use either or neither method. The results revealed that there was no statistically significant association between the use of mosquito bednet and having malaria but that there was a statistically significant association between the use of indoor residual spraying and having malaria. The researcher thus recommends that all households in southern Africa malaria prone areas should be regularly sprayed in addition to any other malaria prevention method that residents might want to use.

The study results further indicate that there was a statistically significant association between some but not all of the sociodemographic and socioeconomic factors and the use of either or none of the malaria prevention methods. Thus the researcher recommends that educational programs should be focused on the fact that indoor residual spraying is more effective than mosquito bednets and targeted to all community members regardless of their socio-economic status and demographic status.

Finally, to avoid the possibility of misclassifying cases as bednet users where in fact the infection happened before they start using bednets or as non-bednet users while the infection happened when in fact they were using a bednet, the researcher recommends that further similar studies should consider collecting data on mosquito bednet usage for 30 days (could be less than 30 but more than 14) prior to data collection to consider the malaria incubation period.

## Implications

The findings of this study may have a great impact on social change. At individual level, anyone who ever suffered from malaria would know how it feels to be malaria free judging from the discomfort caused by the malaria signs and symptoms. For as much as malaria is concerned, an individual free from malaria would be able to function normally on daily basis and in own daily activities and thus improving own economic status. Individuals would be able to save on expenses related to employment loses, treatments and care of the sick, as well as loss of life. This saving would eventually accumulate at community and even society level. For example, it is estimated that preventing malaria would result in US $208.6 billion gain (Purdy, Robinson, Wei, & Rublin, 2013) and for every $1 invested per capita in malaria prevention in Africa the per capita gross domestic product increases by $6.75 (Jobin, 2014). Furthermore, using the most effective malaria prevention method, in this case the indoor residual spraying, would reduce the double effects of chemicals used which are believed to be potentially harmful to human health (Whitworth et al., 2014).

## Conclusions

Malaria is a common problem in southern Africa as well as in other parts of the world. Among several malaria prevention methods the two highly recommended methods are the use of mosquito bednets and indoor residual spraying. This study aimed at comparing these two highly recommended malaria prevention methods. The results of this study indicate that indoor residual spraying is more effective than mosquito bednets when used separately. Thus, households in malaria prone areas should be sprayed in addition to any other preferred malaria prevention method if any. The study results further indicate that some but not all of the sociodemographic and socioeconomic factors are associated with the use of either or none of the malaria prevention methods. Thus the educational programs should be focused on the fact that indoor residual spraying is more effective than mosquito bednets and targeted to all community members regardless of their socio-economic status and demographic status.

References

Agnandji,S. T., Lell, B., Fernandes, J. F., Abossolo, B. P., Methogo, B. G. N., Kabwende, A. L., … Vansadia, P. (2012). A phase 3 trial of RTS, S/AS01 malaria vaccine in African infants. *The New England Journal of Medicine, 367*(24), 2284-2295. Retrieved from http://sfxhosted.exlibrisgroup.com/waldenu?sid=google&auinit=ST&aulast=Agnandji&atitle=A+phase+3+trial+of+RTS,+S/AS01+malaria+vaccine+in+African+infants.&id=pmid:23136909

Ankomah, A., Adebayo, S. B., Arogundade, E. D., Anyanti, J., Nwokolo, E., Ladipo, O., & Meremikwu, M. M. (2012). Determinants of insecticide-treated net ownership and utilization among pregnant women in Nigeria. *BMC Public Health, 12*(105). doi:10.1186/1471-2458-12-105

Anthony, C. N., Lau, Y. L., Sum, J. S., Fong, M. Y., Ariffin, H., Zaw, W. L., … Mahmud, R. (2013). Malaysian child infected with *Plasmodium vivax* via blood transfusion: a case report. *Malaria Journal*, *12*, 308. doi:10.1186/1475-2875-12-308

AreaConnect. (2016). *Angola population and demographics*. Retrieved from http://angola.areaconnect.com/statistics.htm

Aregawi, M., Lynch, M., Bekele, W., Kebede, H., Jima, D., Taffese, H. S., … Coosemans, M. (2014). Time Series Analysis of Trends in Malaria Cases and

Deaths at Hospitals and the Effect of Antimalarial Interventions, 2001–2011, Ethiopia. *PLOS.* https://doi.org/10.1371/journal.pone.0106359

Asidi, A., N'Guessan, R., Akogbeto, M., Curtis, C., & Rowland, M. (2012). Loss of household protection from use of insecticide-treated nets against pyrethroid-resistant mosquitoes, Benin. *Emerging Infectious Diseases, 18*(7). doi:http://dx.doi.org/10.3201/eid1807.120218

Barros, F. M., & Honorio, N. A. (2015). Deforestation and malaria on the Amazon frontier: Larval clustering of anopheles darlingi (Diptera: Culicidae) determines focal distribution of malaria. *The American Journal of Tropical Medicine and Hygiene, 93*(5), 939-953. doi:10.4269/ajtmh.15-0042

Beer, N., Ali, A. S. Eskilsson, H., Jansson, A., Abdul-Kadir, F., Rotllant-Estelrich, G., … Källander, K. (2012). A qualitative study on caretakers' perceived need of bed-nets after reduced malaria transmission in Zanzibar, Tanzania. *BMC Public Health, 12*(606). doi:10.1186/1471-2458-12-606

Berthélemy, J. C., Thuilliez, J., Doumbo, O., & Gaudart, J. (2013). Malaria and protective behaviours: is there a malaria trap? *Malaria Journal*, *12,* 200. doi:10.1186/1475-2875-12-200

Bhatt, S., Weiss, D. J., Cameron, E., Bisanzio, D., Mappin, B., Dalrymple, U., … Gething, P. W. (2015). The effect of malaria control on Plasmodium falciparum in

Africa between 2000 and 2015. *Nature, 526*(7572), 207–211. doi:10.1038/nature15535.

Bi, Y., & Tong, S. (2014). Poverty and malaria in the Yunnan province, China. *Infectious Diseases of Poverty, 3*(32). doi:10.1186/2049-9957-3-32

Boggild, A. K., Geduld, J., Libman, M., Yansouni, C. P., McCarthy, A. E., Hajek, J., … Kain, K. C. (2016). Malaria in travelers returning or migrating to Canada: Surveillance report from CanTravNet surveillance data, 2004–2014. *CMAJ Open, 4*(3), e352. doi:10.9778/cmajo.20150115

Bradley, J., Lines, J., Fuseini, G., Schwabe, C., Monti, F., Slotman, M., … Kleinschmidt, I. (2015). Outdoor biting by *Anopheles* mosquitoes on Bioko Island does not currently impact on malaria control. *Malaria Journal, 14* (170). doi: 10.1186/s12936-015-0679-2

Bradley, J., Matias, A., Schwabe, C., Vargas, D., Monti, F., Nseng, G., & Kleinschmidt, I. (2012). Increased risks of malaria due to limited residual life of insecticide and outdoor biting *versus* protection by combined use of nets and indoor residual spraying on Bioko Island, Equatorial Guinea. *Malaria Journal, 11*, 242. http://doi.org/10.1186/1475-2875-11-242

Cairns, M. E., Walker, P. G. T., Okell, L. C., Griffin, J. T., Garske, T., Asante, K. P., … Milligan, P. J. (2015). Seasonality in malaria transmission: implications for case-management with long-acting artemisinin combination therapy in sub-Saharan Africa. *Malaria Journal*, *14*, 321. doi:10.1186/s12936-015-0839-4

Centers for Disease Control and Prevention. (2012). *Indoor residual spraying*. Retrieved from http://www.cdc.gov/malaria/malaria_worldwide/reduction/irs.html

Centers for Disease Control and Prevention. (2015). *Malaria*. Retrieved from https://www.cdc.gov/malaria/about/disease.html

Centers for Disease Control and Prevention. (2015). *Malaria: Frequently asked questions*. Retrieved from http://www.cdc.gov/malaria/about/faqs.html

Centers for Disease Control and Prevention. (2016a). *Malaria: Frequently asked questions*. Retrieved from https://www.cdc.gov/malaria/about/faqs.html

Centers for Disease Control and Prevention. (2016b). *Impact of malaria*. Retrieved from http://www.cdc.gov/malaria/malaria_worldwide/impact.html

Central Statistical Office, Ministry of Health, University of Zambia Teaching Hospital, Virology Laboratory, University of Zambia Department of Population Studies, Tropical Diseases Research Centre, & The DHS Program ICF International. (2015). *Zambia demographic and health survey 2013-14*. Retrieved from https://www.dhsprogram.com/pubs/pdf/FR304/FR304.pdf

Champion, V. L. & Skinner, C. S. (2008). The health belief model. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory,* *research, and practice*. (4th ed.). (pp. 45-65). USA: Jossey-Bass.

Chaponda, E. B., Chandramohan, D., Michelo, C., Mharakurwa, S., Chipeta, J., & Chico, R. M. (2015). High burden of malaria infection in pregnant women in a rural district of Zambia: a cross-sectional study. *Malaria Journal, 14*(380). doi:10.1186/s12936-015-0866-1

Cheng, H. G., & Phillips, M. R. (2014). Secondary analysis of existing data: Opportunities and implementation. *Shanghai Archives of Psychiatry, 26*(6), 371–375. doi:10.11919/j.issn.1002-0829.21417

Chico. R., Mayaud, P., Ariti, C., Mabey, D., Ronsmans, C. & Chandramohan, D. (2012). Prevalence of malaria and sexually transmitted and reproductive tract infections in pregnancy in sub-Saharan Africa: A systematic review. *JAMA, 307*(19):2079-2086. doi:10.1001/jama.2012.3428

Chitunhu, S., & Musenge, E. (2015). Direct and indirect determinants of childhood malaria morbidity in Malawi: A survey cross-sectional analysis based on malaria indicator survey data for 2012. *Malaria Journal, 14,* 265. doi:10.1186/s12936-015-0777-1

Clemow, L. (2004). *Encyclopedia of health and behavior: Health belief model*. Tousand Oaks: Sage. Retrieved from http://sage-ereference.com.ezp.waldenulibrary.org/view/behavior/n113.xml

Corbel, V., Akogbeto, M., Damien, G. B., Djenontin, A., Chandre, F., Rogier, C., … Henry, M. C. (2012). Combination of malaria vector control interventions in pyrethroid resistance area in Benin: a cluster randomised controlled trial. *The Lancet Infectious Diseases, 12*(8), 617-626. doi:10.1016/S1473-3099(12)70081-6

Cosep Consultoria, Consaúde, & ICF International. (2011). *Angola malaria indicator survey 2011*. Retrieved from https://dhsprogram.com/pubs/pdf/MIS11/MIS11.pdf

Cotter, C., Sturrock, H. J. W., Hsiang, M. S., Liu, J., Phillips, A. A., Hwang, J., … Feachem, R. G. A. (2013). The changing epidemiology of malaria elimination: New strategies for new challenges. *The Lancet, 382*(9895), 900-911. doi:10.1016/S0140-6736(13)60310-4

Creswell, J. W. (2009). *Research design: Quantitative, qualitative, and mised methods approaches* (3rd ed.). London: Sage.

De Castro, M. C., & Fisher, M. G. (2012). Is malaria illness among young children a cause or a consequence of low socioeconomic status? Evidence from the united Republic of Tanzania. *Malaria Journal, 11*, 161. doi:10.1186/1475-2875-11-161

Degefa, T., Yewhalaw, D., Zhou, G., Lee, M., Atieli, H., Githeko, A. K., & Yan, G. (2017). Indoor and outdoor malaria vector surveillance in western Kenya: implications for better understanding of residual transmission. *Malaria Journal 16* (443). doi: 10.1186/s12936-017-2098-z

Demographic and Health Surveys Program. (n.d.). *DHS overview.* Retrieved from http://dhsprogram.com/What-We-Do/Survey-Types/DHS.cfm

Dimas, H. J. (2017). Factors associated with coverage and acceptability of indoor residual spraying (IRS) for malaria prevention in Nassarawa Eggon LGA of Nassarawa State, Nigeria. Retrieved from http://kubanni.abu.edu.ng:8080/jspui/bitstream/123456789/8954/1/FACTORS%20ASSOCIATED%20WITH%20COVERAGE%20AND%20ACCEPTABILITY%20OF%20INDOOR%20RESIDUAL%20SPRAYING%20(IRS)%20FOR%20MALARIA%20PREVENTION%20IN.pdf

Donovan, C., Siadat, B., & Frimpong, J. (2012). Seasonal and socio-economic variations in clinical and self-reported malaria in Accra, Ghana: Evidence from facility data and a community survey. *Ghana Medical Journal, 46*(2), 85-94. Retrieved from http://web.b.ebscohost.com.ezp.waldenulibrary.org/ehost/pdfviewer/pdfviewer?vid=4&sid=6f62e5d2-0074-4c1e-aa90-c5d5bf839621%40sessionmgr120&hid=116

Dotrario, A. B., Bazzo Menon, L. J., Bollela, V. R., Martinez, R., de Almeida e Araujo, D. C., de Fonseca, B. L., & Santana, R. C. (2016). Malaria and other febrile diseases among travellers : The experience of a reference centre located outside the Brazilian Amazon Region. *Malaria Journal, 151*, 11. doi:10.1186/s12936-016-1347-x

Dougnon, T. V., Bankole, H. S., Hounmanou, Y. M. G., Echebiri, S., Atchade, P., & Mohammed, J. (2015). Comparative Study of Malaria Prevalence among Travellers in Nigeria (West Africa) Using Slide Microscopy and a Rapid Diagnosis Test. *Journal of Parasitology Research*, *2015*, 108707. doi:10.1155/2015/108707

Ediau, M., Babirye, J. N., Tumwesigye, N. M., Matovu, J. K. B., Machingaidze, S., Okui, O., … Waiswa, P. (2013). Community knowledge and perceptions about indoor residual spraying for malaria prevention in Soroti district, Uganda: a cross-sectional study. *Malaria Journal*, *12*(170). doi:10.1186/1475-2875-12-170

Ellis, P. D. (2010). *The essential guide to effect sizes: Statistical power, meta-analysis, and the interpretation of research results*. New York: Cambridge.

Ezire, O., Adebayo, S. B., Idogho, O., Bamgboye, E. A., & Nwokolo, E. (2015). Determinants of use of insecticide-treated nets among pregnant women in Nigeria. *International Journal of Women's Health*, *7*, 655-661. doi: 10.2147/IJWH.S77807

Fernando, A. W., Jayakody, S., Wijenayake, H. K., Galappaththy, G. L., Yatawara, M., & Harishchandra, J. (2016). Species composition and population dynamics of malaria vectors in three previously ignored aquatic systems in Sri Lanka. *Malaria Journal*, 151, 9. doi:10.1186/s12936-016-1316-4

Field, A. (2013). *Discovering statistics using IBM SPSS statistics.* (4th ed.). London:

Sage.

Forthofer, R. N., Lee, E. S., & Hernandez, M. (2007). *Biostatistics: A guide to design, analysis and discovery*. Boston: Elsevier.

Frankfort-Nachmias, C. & Nachmias D. (2008). *Research methods in the social sciences*. (7th ed.). New York: Worth.

Fullman, N., Burstein, R., Lim, S. S., Medlin, C., & Gakidou, E. (2013). Nets, spray or both? The effectiveness of insecticide-treated nets and indoor residual spraying in reducing malaria morbidity and child mortality in sub-Saharan Africa. *Malaria Journal, 12*(62). doi:10.1186/1475-2875-12-62

Gimning, J. E., Otieno, P., Were, V., Marwanga, D., Abong'o, D., Wiegand, R., … Hamel, M. J. (2016). The effect of indoor residual spraying on the prevalence of malaria parasite infection, clinical malaria and anemia in an area of perennial transmission and moderate coverage of insecticide treated nets in western Kenya. *PLoS ONE*, *11*(1), e0145282. http://doi.org/10.1371/journal.pone.0145282

Greenhoot, A. F., & Dowsett, C. J. (2012). Secondary data analysis: An important tool for addressing developmental questions. *Journal of Cognition & Development, 13*(1), 2-18. doi:10.1080/15248372.2012.646613

Guimaraes, R. M., Valente, B. C., Faria, P. A., Stephanelli, L. L., Chaiblich, J. V., & Silveira Arjona, F. B. (2016). Deforestation and malaria incidence in the legal

Amazon Region between 1996 and 2012. *Cadernos Saude Coletiva, 24*(1), 3-8. doi:10.1590/1414-462X201500040125

Hahn, M. B., Gangnon, R. E., Barcellos, C., Asner, G. P., & Patz, J. A. (2014). Influence of deforestation, logging, and fire on malaria in the Brazilian Amazon. *PLoS One*, *9*(1), e85725. doi:10.1371/journal.pone.0085725

Haileselassie, B. & Ali A. (2018). Assessment of insecticide treated nets coverage for malaria control in Kafta-Humera District, Tigray: Possession versus use by high-risk groups. *Ethiopian Journal of Health Development*. Retrieved from http://ejhd.org/index.php/ejhd/article/view/510/372

Hanandita, W., & Tampubolon, G. (2016). Geography and social distribution of malaria in Indonesian Papua: A cross-sectional study. *International Journal of Health Geographics, 151*(15). doi:10.1186/s12942-016-0043-y

Ingstad, B., Munthali, A. C., Braathen, S. H., & Grut, L. (2012). The evil circle of poverty: A qualitative study of malaria and disability. *Malaria Journal*, *11*, 15. doi:10.1186/1475-2875-11-15

Jobin, W. R. (2014). Suppression of malaria transmission and increases in economic productivity in African countries from 2007 to 2011. *MalariaWorld Journal, 5*(4). Retrieved from http://www.malariaworld.org/sites/default/files/mwjournal/article/MWJ2014_5_4.

pdf

Kanyangarara, M., Mamini, E., Mharakurwa, S., Munyati, S., Gwanzura, L., Kobayashi, T., … Southern Africa International Centers of Excellence for Malaria Research. (2016). Reduction in malaria incidence following indoor residual spraying with actellic 300 CS in a setting with pyrethroid resistance: Mutasa District, Zimbabwe. *PLoS ONE 11*(3), e0151971. https://doi.org/10.1371/journal.pone.0151971

Kar, N. P., Kumar, A., Singh, O. P., Carlton, J. M., & Nanda, N. (2014). A review of malaria transmission dynamics in forest ecosystems. *Parasites & Vectors*, *7*, 265. doi:10.1186/1756-3305-7-265

Karunamoorthi, K. (2012). Global malaria burden: Socialomics implications. *Journal of Socialomics*, 1:e108. doi:10.4172/2167-0358.1000e108

Kibert, S., Lautze, J., Boelee, E., & McCarthey, M. (2012). How does an Ethiopian dam increase malaria? Entomological determinants around the Koka reservoir. *Tropical Medicine & International Health: TM & IH, 17*(11), 1320-1328. doi:10.1111/j.1365-3156.2012.03077.x

Kibret, S., Lautze, J., McCartney, M., Wilson, G. G., & Nhamo, L. (2015). Malaria impact of large dams in sub-Saharan Africa: maps, estimates and predictions. *Malaria Journal*, *14,* 339. doi:10.1186/s12936-015-0873-2

Kibret, S., Wilson, G. G., Tekie, H., & Petros, B. (2014). Increased malaria transmission around irrigation schemes in Ethiopia and the potential of canal water management for malaria vector control. *Malaria Journal*, *13,* 360. doi:10.1186/1475-2875-13-360

Kigozi, R., Baxi, S. M., Gasasira, A., Sserwanga, A., Kakeeto, S., Nasr, S., … Dorsey, G. (2012). Indoor residual spraying of insecticide and malaria morbidity in a high transmission intensity area of Uganda. *PLoS One, 7*(8), e42857. doi:10.1371/journal.pone.0042857

Kioko, U. M., Mwabu, G., & Kimuyu, P. (2013). The economic impact of malaria on wage earnings in Kenya: A household level investigation. *International Journal of Education and Research, 1*(4). Retrieved from http://www.ijern.com/images/April-2013/09.pdf

Kleinschmidt, I., Schwabe, C., Shiva, M., Segura, J. L., Sima, V., Mabunda, S. A., & Coleman, M. (2009). Combining indoor residual spraying and insecticide-treated net interventions. *The American Journal of Tropical Medicine and Hygiene, 81*(3). 519-524. Retrieved from http://web.b.ebscohost.com.ezp.waldenulibrary.org/ehost/pdfviewer/pdfviewer?vid=8&sid=2374b6a0-9ecc-4968-bd4d-5a1076a9f3a5%40sessionmgr104

Kyu, H. H., Georgiades, K., Shannon, H. S., & Boyle, M. L. (2013). Evaluation of the association between long-lasting insecticidal nets mass distribution campaigns and child malaria in Nigeria. *Malaria Journal*, *12*(14). doi:10.1186/1475-2875-12-14

Larsen, D. A., Borrill, L., Patel, R., & Fregosi, L. (2017). Reported community-level indoor residual spray coverage from two-stage cluster surveys in sub-Saharan Africa. *Malaria Journal, 16*(249). doi: 10.1186/s12936-017-1893-x

Laureate Education, Inc. (2012). Secondary data analysis. Retrieved from http://researchcenter.waldenu.edu/Research_Tutorials/Secondary_Data_Analysis/documents/Secondary_Data_Analysis.pdf

Lindblade, K. L., Mwandama, D., Steinhardt, L., Gimning, J., Shah, M., … Mathanga, D. P. (2015). A cohort study of the effectiveness of insecticide-treated bed nets to prevent malaria in an area of moderate pyrethroid resistance, Malawi. *Malaria Journal, 14*(31). doi:10.1186/s12936-015-0554-1

Loll, D. K., Berthe, S., Faye, S. L., Wone, I., Arnold, B., Koenker, H., … Weber, R. (2014). "You need to take care of it like you take care of your soul": Perceptions and behaviors related to mosquito net damage, care, and repair in Senegal. *Malaria Journal, 13*(1), 322-333. doi:10.1186/1475-2875-13-322

Maselli, L. M., Levy, D., Laporta, G. Z., Monteiro, A. M., Fukuya, L. A., Ferreira-da-Cruz, M. F., … Bydlowski, S. P. (2014). Detection of *Plasmodium falciparum* and *Plasmodium vivax* subclinical infection in non-endemic region:

Implications for blood transfusion and malaria epidemiology. *Malaria Journal*, *13*, 224. doi:10.1186/1475-2875-13-224

Metta, E., Haisma, H., Kessy, F., Hutter, I., & Bailey, A. (2014). “We have become doctors for ourselves”: Motives for malaria self-care among adults in southeastern Tanzania. *Malaria Journal*, *13*(1), 1-24. doi:10.1186/1475-2875-13-249

Ministry of Health and Social Services & Namibia Statistics Agency. (2014). *Namibia demographic and health survey 2013*. Retrieved from https://dhsprogram.com/pubs/pdf/FR298/FR298.pdf

Moon, T. D., Hayes, C. B., Blevins, M., Lopez, M. L., Green, A. F., González-Calvo, L., … The Ogumaniha-SCIP Zambézia Consortium. (2016). Factors associated with the use of mosquito bed nets: results from two cross-sectional household surveys in Zambézia Province, Mozambique. *Malaria Journal*, *15*(196). doi:10.1186/s12936-016-1250-5

Mungrue, K., Edwards, J., Fyzul, A., Boodhai, B., Narinesingh, A., & Nanlal, S. (2015). Towards the elimination of syphilis in a small developing country. *Journal of Sexually Transmitted Diseases*. doi:10.1155/2015/801437

Munguambe, K., Pool, R., Montgomery, C., Bavo, C., Nhacolo, A., Fiosse, L. … Alonso, P. (2011). What drives community adherence to indoor residual spraying (IRS) against malaria in Manhiça district, rural Mozambique: a qualitative study.

*Malaria Journal, 10*(344). Retrieved from https://malariajournal.biomedcentral.com/track/pdf/10.1186/1475-2875-10-344?site=malariajournal.biomedcentral.com

Murray, C. J. L., Rosenfeld, L. C., Lim, S. S., Andrews, K. G., Foreman K. J., Haring, D., … Lopez, A. D. (2012). Global malaria mortality between 1980 and 2010: a systematic analysis. *The Lancet, 379*, 413-431. Retrieved from http://ac.els-cdn.com.ezp.waldenulibrary.org/S0140673612600348/1-s2.0-S0140673612600348-main.pdf?_tid=5cd2f3ba-8d2b-11e5-a3ae-00000aacb362&acdnat=1447765488_f6942f9484e570fbda4c323540bdc9ba

Namibia Statistics Agency. (n.d.). *Namibia 2011 population and housing census main report*. Retrieved from http://cms.my.na/assets/documents/p19dmn58guram30ttun89rdrp1.pdf

Nansseu, J. R. N., Noubiap, J. J. N., Ndoula, S. T., Zeh, A. F. M., & Monamele, C. G. (2013). What is the best strategy for the prevention of transfusion-transmitted malaria in sub-Saharan African countries where malaria is endemic? *Malaria Journal*, *12*, 465. doi:10.1186/1475-2875-12-465

Ndiath, M. O., Mazenot, C., Sokhna, C., & Trape, J. F. (2014). How the malaria vector *Anopheles gambiae* adapts to the use of insecticide-treated nets by African populations. *PLoS One, 9*(6), e97700. doi:10.1371/journal.pone.0097700

Negi, G., Gupta, V., Srivastava, V., & Gaur, D. S. (2014). Malaria positivity among blood donors: An important index to assess blood safety. *Journal of Parasitic Diseases: Official Organ of the Indian Society for Parasitology, 38*(1), 1–3. doi:10.1007/s12639-012-0194-0

Njau, J. D., Stephenson, R., Menon, M., Kachur, S. P., & McFarland, D. A. (2013). Exploring the impact of targeted distribution of free bed nets on households bed net ownership, socio-economic disparities and childhood malaria infection rates: analysis of national malaria survey data from three sub-Saharan Africa countries. *Malaria Journal*, *12,* 245. Doi:10.1186/1475-2875-12-245

Noriko, W., Akira, K., Sam, Y., Hope, L., George, T., Takeo, T., … Larson, P. S. (2014). Determinants of the use of insecticide-treated bed nets on islands of pre- and post-malaria elimination: An application of the health belief model in Vanuatu. *Malaria Journal*, *13*(1), 1-26. doi:10.1186/1475-2875-13-441

Okumu, F. O., & Moore, S. J. (2011). Combining indoor residual spraying and insecticide-treated nets for malaria control in Africa: A review of possible outcomes and an outline of suggestions for the future. *Malaria Journal, 10*(208). Retrieved from http://www.biomedcentral.com/content/pdf/1475-2875-10-208.pdf

Okumu, F. O., Kiware, S. S., Moore, S. J., & Killeen, G. F. (2013). Mathematical evaluation of community level impact of combining bed nets and indoor residual spraying upon malaria transmission in areas where the main vectors are *Anopheles arabiensis* mosquitoes. *Parasites & Vectors*, *6*, 17. http://doi.org/10.1186/1756-3305-6-17

Okumu, F. O., Mbeyela, E., Lingamba, G., Moore, J., Ntamatungiro, A. J., Kavishe, D. R., … Moore, S. J. (2013). Comparative field evaluation of combinations of long-lasting insecticide treated nets and indoor residual spraying, relative to either method alone, for malaria prevention in an area where the main vector is *Anopheles arabiensis*. *Parasites & Vectors*, *6*, 46. http://doi.org/10.1186/1756-3305-6-46

Olotu, A., Fegan, G., Wambua, J., Nyangweso, G., & Awuondo, K. (2013). Four-year efficacy of RTS,S/AS01E and its interaction with malaria exposure. *The New England Journal of Medicine* *368*(12), 1111-1120. Retrieved from http://sfxhosted.exlibrisgroup.com/waldenu?sid=google&auinit=A&aulast=Olotu&atitle=Four-year+efficacy+of+RTS,+S/AS01E+and+its+interaction+with+malaria+exposure&id=doi:10.1056/NEJMoa1207564&title=The+New+England+journal+of+medicine&volume=368&issue=12&date=2013&spage=1111&issn=0028-4793

Onabanjo, O. D., & Nwokocha, E. E. (2012). Dying along the ladder of stratification: A view of rural – urban dichotomy in malaria treatment among pregnant women in Ondo State. *Gender & Behavior*, *10*(2), 4792-4812. Retrieved from http://web.a.ebscohost.com.ezp.waldenulibrary.org/ehost/pdfviewer/pdfviewer?vid=3&sid=f0988a60-9ab2-4601-81d7-dded37cfb364%40sessionmgr4004&hid=4209

Onwujekwe, O., Uguru, N., Etiaba, E., Chikezie, I., Uzochukwu, B., & Adjagba, A. (2013). The economic burden of malaria on households and the health system in Enugu State southeast Nigeria. *PLoS One*, *8*(11), e78362. doi:10.1371/journal.pone.0078362

Owusu Adjah, E. S., & Panayiotou, A. G. (2014). Impact of malaria related messages on insecticide-treated net (ITN) use for malaria prevention in Ghana. *Malaria Journal,13*(123). doi**:**10.1186/1475-2875-13-123

Owusuku-Ofori, A. K., Betson, M., Parry, C. M., Stothard, J. R., & Bates, I. (2013). Transfusion-transmitted malaria in Ghana. *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America, 56*(12), 1735-1741. doi:10.1093/cid/cit130

Owusu-Ofori, A., Gadzo, D., & Bates, I. (2016). Transfusion-transmitted malaria: Donor prevalence of parasitaemia and a survey of healthcare workers knowledge and practices in a district hospital in Ghana. *Malaria Journal, 151*, 7. doi:10.1186/s12936-016-1289-3

Owusu-Ofori, A., Owusu-Ofori, S., & Bates, I. (2015). Transfusion-transmitted malaria in sub-Saharan Africa. *ISBT Science Series, 10*, 206-210. doi:10.1111/voxs.12138

Pinder, M., Jawara, M., Jarju, L. B., Salami, K., Jeffries, D., Adiamoh, M., … Lindsay, S. W. (2015). Efficacy of indoor residual spraying with dichlorodiphenyltrichloroethane against malaria in Gambian communities with high usage of long-lasting insecticidal mosquito nets: a cluster-randomised controlled trial. *The Lancet*, *385*(9976), 1436 – 1446. doi:10.1016/S0140-6736(14)61007-2.

Protopopoff, N., Wright, A., West, P. A., Tigererwa, R., Mosha, F. W., Kisinza, W., … Rowland, M. (2015). Combination of insecticide treated nets and indoor residual spraying in northern Tanzania provides additional reduction in vector population density and malaria transmission rates compared to insecticide treated nets alone: A randomised control trial. *PLoS ONE,10*(11), e0142671. http://doi.org/10.1371/journal.pone.0142671

Public Health England. (2016). *Imported malaria cases and deaths in the UK: 1996 to 2015*. Retrieved from https://www.gov.uk/government/publications/imported-malaria-in-the-uk-statistics

Pulford, J., Oakiva, T., Angwin, A., Bryant, M., Mueller, I., & Hetzel, M. W. (2012). Indifferent to disease: A qualitative investigation of the reasons why some Papua New Guineans who own mosquito nets choose not to use them. *Social Science &*

*Medicine, 75*(12), 2283-2290. doi:10.1016/j.socscimed.2012.08.030

Purdy, M., Robinson, M., Wei, K., & Rublin, D. (2013). The economic case for combating malaria. *The American Journal of Tropical Medicine and Hygiene, 89*(5), 819-823. doi:10.4269ajtmh.12-0689

Quenneh, T. N. (2016). *Insecticide treated nets as an effective malaria control strategy in Liberia* (Doctoral dissertation). Retrieved from https://search-proquest-com.ezp.waldenulibrary.org/pqdtlocal1005747/docview/1759630593/BB1249F8A0744ECAPQ/1?accountid=14872 (10002503)

Ranson, H., N'Guessan, R., Lines, J., Moiroux, N., Nkuni, Z., & Corbel, V. (2011). Pyrethroid resistance in African anopheline mosquitoes: what are the implications for malaria control? *Trends in Parasitology, 27*(2), 91-98. doi:10.1016/j.pt.2010.08.004

Raouf, S., Mpimbaza, A., Kigozi, R., Sserwanga, A., Rubahika, D., Katamba, H., … Dorsey, G. (2017). Resurgence of malaria following discontinuation of indoor residual spraying of insecticide in an area of Uganda with previously high-transmission intensity. *Clinical Infectious Diseases, 65*(3), 453-460. doi: 10.1093/cid/cix251

Ren, J., Guo, X. L., Lu, Z. L., Zhang, J. Y., Tang, J. L., Chen, X., … Xu, A. Q. (2016). Ideal cardiovascular health status and its association with socioeconomic factors in Chinese adults in Shandong, China. *BMC Plublic Health, 16*(1), 1-7.

doi:10.1186/s12889-016-3632-6

Russell, T. L., Beebe, N. W., Bugoro, H., Apairamo, A., Chow, W. K., Cooper, R. D., … Burkot, T. R. (2016). Frequent blood feeding enables insecticide-treated nets to reduce transmission by mosquitoes that bite predominately outdoors. *Malaria Journal*, *15* (156), doi:10.1186/s12936-016-1195-8

Ruyange, M. M., Condo, J., Karema, C., Binagwaho, A., Rukundo, A., & Muyirukazi, Y. (2016). Factors associated with the non-use of insecticide-treated nets in Rwandan children. *Malaria Journal, 15*(355). doi: 10.1186/s12936-016-1403-6

Selemani, M., Msengwa, A. S., Mrema, S., Shamte, A., Mahande, M. J., Yeates, K., … Lutambi, A. M. (2016). Assessing the effects of mosquito nets on malaria mortality using a space time model: A case study of Rufiji and Ifakara Health and Demographic Surveillance System sites in rural Tanzania. *Malaria Journal, 15*, 1-14. doi:10.1186/s12936-016-1311-9

Sena, L., Deressa, W., & Ali, A. (2015). Correlation of climate variability and malaria: A retrospective comparative study, southwest Ethiopia. *Ethiopian Journal of Health Sciences*, *25*(2), 129-138. doi:10.4314/ejhs.v25i2.5

Sewe, M. O., Ahm, C., & Rocklöv, J. (2016). Remotely sensed environmental conditions and malaria mortality in three malaria endemic regions in western Kenya. *Plos ONE*, *11*(4), 1-16. doi:10.1371/journal.pone.0154204

Seyoum, D., Kifle, Y. G., Rondeau, V., Yewhalaw, D., Duchateau, L., Rosas-Aguirre, A., & Speybroeck, N. (2016). Identification of different malaria patterns due to *Plasmodium falciparum* and *Plasmodium vivax* in Ethiopian children: a prospective cohort study. *Malaria Journal*, *15*, 208. doi:10.1186/s12936-016-1253-2

Sicuri, E., Vieta, A., Lindner, L., Constenla, D., & Saunpin, C. (2013). The economic cost of malaria in children in three sub-Saharan countries: Ghana, Tanzania and Kenya. *Malaria Journal, 12*(307). doi:10.1186/1475-2875-12-307

Smith, A. K., Ayanian, J. Z., Covinsky, K. E., Landon, B. E., McCarthy, E. P., Wee, C. C., & Steinman, M. A. (2011). Conducting high-value secondary dataset analysis: An introductory guide and resources. *Journal of General Internal Medicine*, *26*(8), 920–929. doi:10.1007/s11606-010-1621-5

Sougoufara, S., Diédhiou, S. M., Doucouré, S., Diagne, N., Sembène, P. M., Harry, M., …. Ndiath, M. O. (2014). Biting by *Anopheles funestus* in broad daylight after use of long-lasting insecticidal nets: a new challenge to malaria elimination. *Malaria Journal 13* (125). doi: 10.1186/1475-2875-13-125

Steinhardt, L. C., Yeka, A., Nasr, S., Wiegand, R. E., Rubahika, D., Sserwanga, A., … Filler, S. (2013). The effect of indoor residual spraying on malaria and anemia in high transmission area of northern Uganda. *The American Journal of Tropical Medicine and Hygiene*, *88*(5), 855-861. doi:1.4269ajtmh.12-0747

Strode, C., Donegan, S., Garner, P., Enayati, A., & Hemingway, J. (2014). The impact of Pyrethroid resistance on the efficacy of insecticide-treated bed nets against African Anopheline mosquitoes: Systematic review and meta-analysis. *Plos Medicine, 11*(13). Retrieved from http://eds.a.ebscohost.com.ezp.waldenulibrary.org/eds/pdfviewer/pdfviewer?vid=12&sid=44c3db6e-6ddc-4664-9ca7-4f0898b47288%40sessionmgr4009&hid=4113

Sullivan, T. R., Salter, A. B., Ryan, P. & Lee, K. J. (2015). Bias and precision of the "Multiple Imputation, Then Deletion" method for dealing with missing outcome data. American Journal of Epidemiology, 182 (6). doi: 10.1093/aje/kwv100

Suresh, K., & Chandrashekara, S. (2012). Sample size estimation and power analysis for clinical research studies. *Journal of Human Reproductive Sciences*, *5*(1), 7–13. doi:10.4103/0974-1208.97779

Sy, O., Niang, E. A., Ndiaye, M., Konaté, L., Diallo, Elhadji Conco Ciré Ba, E. C., … Faye, O. (2018). Entomological impact of indoor residual spraying with pirimiphos-methyl: a pilot study in an area of low malaria transmission in Senegal. *Malaria Journal, 17*(64). doi: 10.1186/s12936-018-2212-x

Szklo, M. & Nieto, F. J. (2014). *Epidemiology: Beyond the basics*. (3rd ed.). Burlington: Jones and Bartlett.

Tan, K. R., Cullen, K. A., Koumans, E. H., & Arguin, P. M. (2016). Inadequate diagnosis and treatment of malaria among travelers returning from Africa during the Ebora epidemic: United States, 2014 – 2015. *MMWR: Morbidity & Mortality Weekly Report*, *65*(2), 27-29. doi:10.15585/mmwr.mm6502a3

Temu, E. A., Coleman, M., Abilio, A. P., & Kleinschmidt, I. (2012). High prevalence of malaria in Zambezia, Mozambique: The protective effect of IRS versus increased risks due to pig-keeping and house construction. *PLoS One 7*(2): e31409. doi:10.1371/journal.pone.0031409

Texier, G., Machault, V., Barragti, M., Boutin, J.-P., & Rogier, C. (2013). Environmental determinant of malaria cases among travellers. *Malaria Journal*, *12*, 87. doi:10.1186/1475-2875-12-87

The Himmrlfarb Health Sciences Library. (2011). *Study design 101*. Retrieved from https://himmelfarb.gwu.edu/tutorials/studydesign101

Trape, J. F., Tall, A., Diagne, N., Ndiath, O., Ly, A. B., Faye, J., … Sokhna, C. (2011). Malaria morbidity and pyrethroid resistance after the introduction of insecticide-treated bed nets and artemisinin-based combination therapies: a longitudinal study. *Lancet Infectious Diseases,11*, 925-932. doi:10.1016/S1473-3099(11)70194-3

Tukei, B. B., Beke, A., & Lamadrid-Figueroa, H. (2017). Assessing the effect of indoor residual spraying (IRS) on malaria morbidity in Northern Uganda: a before and after study. *Malaria Journal, 16*(4). doi: 10.1186/s12936-016-1652-4

Tusting, L. S., Willey, B., Lucas, H., Thompson, J., Kafy, H. T., Smith, R., & Lindsay, S. W. (2013). Socioeconomic development as an intervention against malaria: A systematic review and meta-analysis. *The Lancet, 382*(9896), 963-972. doi:10.1016/S0140-6736(13)60851-X

Valle, D., & Clark, J. (2013). Conservation efforts may increase malaria burden in the Brazilian Amazon. *PLoS One*, *8*(3), e57519. doi:10.1371/journal.pone.0057519

Wadunde, I., Mpimbaza, A., Musoke, D., Ssempebwa, J. C., Ediau, M., Tuhebwe, D., … Wanyenze, R. K. (2018). Factors associated with willingness to take up indoor residual spraying to prevent malaria in Tororo district, Uganda: a cross-sectional study. *Malaria Journal*, *17*(5). doi: 10.1186/s12936-017-2163-7

Wang, X., Zhou, G., Zhong, D., Wang, X., Wang, Y., Yang, Z., … Yan, G. (2016). Life-table studies revealed significant effects of deforestation on the development and survivorship of *Anopheles minimus* larvae. *Parasites & Vectors*, *9*, 323. doi:10.1186/s13071-016-1611-5

Wantanabe, N., Kaneko, A., Yamar, S., Leodoro, H., Taleo, G., Tanihata, T., … Larson, P. S. (2014). Determinants of the use of insecticide-treated bed nets on islands of pre- and post-malaria elimination: An application of the health belief model in Vanuatu. *Malaria Journal, 13*(441). doi:10.1186/1475-2875-13-441

West, P. A., Protopopoff, N., Rowland, M., Cumming, E., Rand, A., Drakeley, C., … Kleinschmidt, I. (2013). Malaria risk factors in north west Tanzania: The effect of spraying, nets and wealth. *PLoS One, 8*(6), e65787. doi:10.1371/journal.pone.0065787

West, P. A., Protopopoff, N., Wright, A., Kivaju, Z., Tigererwa, R., Mosha, F. W., … Kleinschmidt, I. (2015). Enhanced protection against malaria by indoor residual spraying in addition to insecticide treated nets: Is it dependent on transmission intensity or net usage? *PLoS One,10*(3), e0115661. doi:10.1371/journal.pone.0115661

West, P. A., Protopopoff, N., Wright, A., Kivaju, Z., Tigererwa, R., Mosha, F. W., … Kleinschmidt, I. (2014). Indoor residual spraying in combination with insecticide-treated nets compared to insecticide-treated nets alone for protection against malaria: A cluster randomised trial in Tanzania. *PLoS Medicine, 11*(4), e1001630. http://doi.org/10.1371/journal.pmed.1001630

White, M. T., Conteh, L., Cibulskis, R., & Ghani, A. C. (2011). Costs and cost-effectiveness of malaria control interventions - a systematic review. *Malaria Journal, 10(337).* doi:10.1186/1475-2875-10-337

White, N. J., Pukrittayakamee, S., Hien, T. T., Faiz, M. A., Mokuolu, O. A., & Dondorp, A. M. (2013). Malaria. *The Lancet, 383*, 723-735. doi:http://dx.doi.org/10.1016/S0140-6736(13)60024-0

Whitworth, K. W., Bornman, R. M. S., Archer, J. I., Kudumu, M. O., Travlos, G. S., Wilson, R. E., & Longnecker, M. P. (2014). Predictors of plasma DDT and DDE concentrations among women exposed to indoor residual spraying for malaria control in the South African study of women and babies (SOWB). *Environmental Health Perspectives, 122*(6), 545-552. doi:10.1289/ehp.1307025

World Health Organization. (2014). *Review of current evidence on combining indoor residual spraying and long-lasting insecticidal nets*. Retrieved from http://www.who.int/malaria/mpac/background-combining-irs-llins-mar2014.pdf

World Health Organization. (2015). Malaria. Retrieved from http://www.who.int/mediacentre/factsheets/fs094/en/

World Health Organization. (2018). *International travel and health: Malaria*. Retrieved from http://www.who.int/ith/diseases/malaria/en/

Yewhalaw, D., Getachew, Y., Tushune, K., W/Michael, K., Kassahun, W., Duchateau, L., & Speybroeck, N. (2013). The effect of dams and seasons on malaria incidence and anopheles abundance in Ethiopia. *BMC Infectious Diseases*, *13*, 161. doi:10.1186/1471-2334-13-161

Zhou, G., Afrane, Y. A., Malla, S., Githeko, A. K., & Yan, G. (2015). Active case surveillance, passive case surveillance and asymptomatic malaria parasite screening illustrate different age distribution, spatial clustering and seasonality in western Kenya. *Malaria Journal*, *14*, 41. doi:10.1186/s12936-015-0551-4

Zimbabwe National Statistics Agency (ZIMSTAT) & ICF International. (2012). *Zimbabwe demographic and health survey 2010-11*. Retrieved from https://dhsprogram.com/pubs/pdf/FR254/FR254.pdf

Zimbabwe National Statistics Agency. (n.d.). *Zimbabwe population census 2012*. Retrieved from http://196.43.99.13/sites/default/files/img/National_Report.pdf

Appendix: Permission to Use Demographic and Health Survey Program Data

**archive@dhsprogram.com**
To
ferdinand50na@yahoo.com
11/23/15 at 8:51 PM
**See Attached.**

You have been authorized to download data from the Demographic and Health Surveys (DHS) Program. This authorization is for unrestricted countries requested on your application, and the data should only be used for the registered research or study. To use the data for another purpose, a new research project request should be submitted. This can be done from the "Create A New Project" link in your user account.

All DHS data should be treated as confidential, and no effort should be made to identify any household or individual respondent interviewed in the survey. The data sets must not be passed on to other researchers without the written consent of DHS. Users are required to submit a copy of any reports/publications resulting from using the DHS data files. These reports should be sent to: archive@dhsprogram.com.

To begin downloading datasets, please login at: http://www.dhsprogram.com/data/dataset_admin/login_main.cfm

Once you are logged in, you may also edit your contact information, change your email/password, request additional countries or Edit/Modify an existing Description of Project.

If you are a first time user of DHS Data, please view the following videos on downloading and opening DHS data:
http://www.dhsprogram.com/data/Using-DataSets-for-Analysis.cfm#CP_JUMP_14039

Additional resources to help you analyze DHS data efficiently include:
http://dhsprogram.com/data/Using-Datasets-for-Analysis.cfm, a video on Introduction to DHS Sampling Procedures - found at: http://youtu.be/DD5npelwh80 and a video on Introduction to Principles of DHS Sampling Weights - found at: http://youtu.be/SJRVxvdIc8s

The files you will download are in zipped format and must be unzipped before analysis. Following are some guidelines:

After unzipping, print the file with the .DOC extension (found in the Individual/Male Recode Zips). This file contains useful information on country specific variables and differences in the Standard Recode definition.

Please download the DHS Recode Manual: http://dhsprogram.com/publications/publication-dhsg4-dhs-questionnaires-and-manuals.cfm

The DHS Recode Manual contains the documentation and map for use with the data. The Documentation file contains a general description of the recode file, including the rationale for recoding; coding standards; description of variables etc. The Map file contains a listing of the standard dictionary with basic information relating to each variable.

It is essential that you consult the questionnaire for a country, when using the data files. Questionnaires are in the appendices of each survey's final report: http://dhsprogram.com/publications/publications-by-type.cfm

We also recommend that you make use of the Data Tools and Manuals: http://www.dhsprogram.com/accesssurveys/technical_assistance.cfm

For problems with your user account, please email archive@dhsprogram.com.

For data questions, we recommend that users register to participate in the DHS Program User Forum at: http://userforum.dhsprogram.com

The Demographic and Health Surveys (DHS) Program
ICF INTERNATIONAL
530 Gaither Road
Suite 500
Rockville, MD 20850
USA
LOGIN INFORMATION:
Login Email: ferdinand50na@yahoo.com
Password: (use the password you entered when you registered)