UNIVERSITY of RWANDA

A COMPARATIVE ANALYSIS OF RISK FACTORS OF MALARIA. CASE STUDY OF BUGESERA AND GISAGARA DISTRICT DHS 2014/2015.

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A COMPARATIVE ANALYSIS OF RISK FACTORS OF MALARIA. CASE STUDY OF BUGESERA AND GISAGARA DISTRICT DHS 2014/2015.

By

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In the College of Medicine and Health Sciences, University of Rwanda.

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ABSTRACT

Background

Malaria is still a public health concern in worldwide. A figure of 3.2 billion people is at risk of malaria a report of World Health Organization in 2013. A proportion of 89 and 91 cases of malaria reported during 2015 were respectively attributed to malaria cases and malaria deaths in Sub-Saharan Africa.

Different countries in Africa are reported by Global Forum report to eradicate malaria including Algeria whereby during 2017 was asking a free malaria certificate.

Rwanda is among the Sub-Saharan Africa located in East Africa. The several reports indicate that from 2001 to 2011, malaria cases increased considerably especially in Eastern and Southern Province with five million cases. The affected districts included Bugesera in the Eastern and Gisagara in the Southern Province of Rwanda with a share of 41% of the country prevalence in 2014 and during 2017-2018 a figure of 11 deaths was attributed to malaria and both Gisagara and Bugesera Districts were the high burdened.

Methodology

The RDHS 2014-2015 data was used for the study and a cross-sectional survey was used in which two clusters were considered both Gisagara and Bugesera Districts in the Southern and Eastern Province of Rwanda. Bivariate analysis was used to determine the significant predictors with malaria and reduced logistic regression model was used.

Results

The results of the study show that not having mosquito bed nets for sleeping is 0.264 times less likely of having malaria than those who have mosquito bed nets in Gisagara District. In Bugesera District, living in low altitude is 2.768 times more likely associated with the risk of getting malaria than living in high altitude.

Conclusion

The results of the study concluded that environmental and geographical factor such as low altitude is the risk factor associated with malaria than the high altitude in Bugesera District. While not having mosquito bed nets for sleeping is the protective factor for malaria than those who have it in Gisagara District. On the other hand, socio-economic and demographic characteristics do not have any effect with malaria on the results of the study.

RESUME

Contexte

Le paludisme reste un problème de santé publique dans le monde entire. 3,2 milliards de personnes sont à risque de paludisme. Une proportion de 89 et 91 cas de paludisme notifiés en 2015 étaient respectivement attribués à des cas de paludisme et à des décès en paludisme en Afrique subsaharienne. Selon le rapport du Forum mondial, différents pays d'Afrique auraient éradiqué le paludisme, notamment l'Algérie, qui demandait en 2017 un certificat gratuit de paludisme. Le Rwanda fait partie de l'Afrique subsaharienne située en Afrique orientale. Plusieurs rapports indiquent qu'entre 2001 et 2011, les cas de paludisme ont considérablement augmenté, en particulier dans les provinces de l'Est et du Sud, avec cinq millions de cas. Les districts touchés comprenaient Bugesera à l'est et Gisagara dans la province méridionale du Rwanda, avec une part de 41% de la prévalence dans le pays en 2014; en 2017-2018, 11 décès ont été attribués au paludisme et les districts de Gisagara et de Bugesera haut chargé.

Méthodologie

Les données de l'EDSR 2014-2015 ont été utilisées pour l'étude et un plan d'étude transversal a été utilisé dans lequel deux groupes étaient considérés à la fois dans les districts de Gisagara et de Bugesera dans les provinces du sud et l'est du Rwanda. Une analyse bivariée a été utilisée pour déterminer les prédicteurs significatifs du paludisme et un modèle de régression logistique réduit a été utilisé.

Résultats

Les résultats de l'étude montrent que ne pas avoir des moustiquaires pour dormir est 0,264 fois moins susceptible de présenter un risque de paludisme que ceux qui ont de la moustiquaire dans le district de Gisagara. Dans le district de Bugesera, le risque de paludisme est de 2,768 fois plus que le fait de vivre en basse altitude par rapport à ceux qui vivaient en haute altitude.

Conclusion

Les résultats de l'étude ont conclu que des facteurs environnementaux et géographiques tels que la basse altitude sont les facteurs de risque associés au paludisme que la haute altitude dans le district de Bugesera. Le fait de ne pas avoir des moustiquaires pour dormir est un facteur de protection contre le paludisme que pour ceux qui ont des moustiquaires dans le district de Gisagara. D'autre part, les caractéristiques socio-économiques et démographiques n'ont eu aucun effet avec le paludisme sur les résultats de l'étude.

DEDICATION

This research is dedicated to;

To God,

To my wife and Children,

To my Uncle,

To my thesis supervisor,

To the academic staffs,

To the entire family who encouraged me during the period of my study,

To all people who believe in God.

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Almighty for his love and mercy touched all life and every day and through my study.

The people who tough me hard working including their advice especially my thesis supervisor Prof. Cyprien MUNYANSHONGORE for his assistance and guidance through which skills and knowledge gained.

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The non-forgettable support for my lovely wife, thank you for all.

LIST OF ABBREVIATIONS & ACRONYMS

AMR : Americas Region
AFR : African Region
CHWs : Community Health Workers
EMR : Eastern Mediterranean Region
GDP : Global Technical
GTS : Global Technical Strategy for Malaria
HMIS : Health Management Information System
ICCM : Integrated Community Case Management
ITNs : Insecticide Treated Nets
IRS : Indoor Residual Spraying
LMIC : Low and Middle Income Countries
LLITN : Long Lasting Insecticide Treated Nets
MEPR : Malaria Elimination Program for Ruhuha
NMEP : National Malaria Elimination Program
RDHS : Rwanda Demographic and Health Survey
SEAR : South East Asia Region
UK : United Kingdom
WHO : World Health Organization
WPR : Western Pacific Region

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CHAPTER ONE: INTRODUCTION

1.1. Definition of key concepts(1) :

Malaria: is a mosquito borne infectious disease affecting human and other animals caused by parasitic single-celled microorganisms belonging to the plasmodium group.

Indoor residual spraying: Operational procedures and strategies for Malaria vector control involving spraying interior surface of dwelling with a residual insecticide to kill or repel endophilic mosquitoes.

Malaria elimination: Interruption of local transmission (reduction to zero incidences of indigenous cases) of a specified malaria parasite in a defined geographical area as a result of deliberate activities. Continued measures to prevent re-establishment of transmission are required (Note: The certification of malaria elimination in a country will require that local transmission is interrupted for all human malaria parasites).

1.2. Background

Malaria is caused by infection with protozoan parasites of the Plasmodium species. Plasmodium falciparum is widespread in African countries while P. vivax, P. ovale, and P. malariae infections are less common and geographically restricted. The parasites are transmitted by Anopheles mosquitoes, with An. gambiae sensu stricto, An. funestus, and An. Arabiensis being the most prevalent in African counties.

Malaria remains a major public health problem worldwide. Estimates of 3.2 billion people worldwide are reported to be at risk of malaria by The World Health Organization in 2013 (WHO). During 2015, 89% of malaria cases and 91% of malaria deaths of the global burden of malaria were attributed to Sub-Saharan Africa(2,3).

Between 2001 and 2015, policies for malaria control interventions in Sub-Saharan Africa countries highlighted that Insecticide-treated nets (LLITNs) and Indoor residual spraying (IRS) contributed for 70% of the 943 million in reduction of malaria cases(3).

In East-Africa, Uganda ranked at the third position of total malaria cases among African countries and Mauritius is the only Sub-Saharan country to achieve malaria elimination target(4,5).

Algeria is the one of the countries aiming to eliminate malaria, thus, the second Global Forum report the zero indigenous case of malaria during 2017 which was the fourth consecutive year of the similar report on malaria cases for Algeria, whereby 448 imported cases and seven introduced cases. The only high risk of malaria cases in Algeria includes the area of the Southern Province of Tamanrasset bordering both Mali and Niger considered as the endemic area attributed 81% of the imported malaria. Therefore, Algeria requested the free-malaria certificate from World Health Organization(6).

From 2002 to 2011, the Rwandan Health Facilities reported more than five millions cases. Therefore, during 2005 to 2012, a recorded of 86% and 74% reduction in malaria incidence and malaria mortality respectively was observed in Rwanda. During 2013, one million of malaria cases were reported and high prevalence was observed in rural areas(2–4).

An estimated Malaria incidence in Rwanda decreased from 418 per 1000 during the period of 2016-2017 to 389 per 1000 in 2017-2018.However, during 2012 an increase in malaria cases with the most affected Districts of Bugesera, Kamonyi and Gisagara Districts was observed(2,3).
The reports revealed that the risk factors attributed to the increase of malaria in Rwanda are Substandard Long Lasting Insecticide treated Nets (LLINs), Climatic data anomalies such as rainfall and changes in ambient temperature and Insecticide resistance through documented emerging parathyroid resistance all of these factors contributed high burden of malaria in Rwanda(2,3).

During 2014, the reports have shown that the high malaria burden presented mostly in districts located in Eastern Province represent a prevalence of 41% of the total cases and these are: Kirehe, Ngoma, Bugesera, Kayonza, Rwamagana.
In Southern Province, the districts with high burden of malaria represent a prevalence of 38% of total cases of malaria. These are : Gisagara, Nyanza, Huye, Kamonyi, Ruhango, Muhanga(1,7).
During 2017- 2018 reports revealed that a record of 11 death cases and plus attributed to malaria where by Gisagara and Bugesera were among the top high with malaria deaths cases.
Therefore, in a period of 2017-2018, 13 districts were identified to be high endemic areas of malaria including Gisagara and Bugesera Districts(1,7).

Malaria incidence trends could be attributed to the factors such as climatic, environmental and socio-economic factors(5,7,8).
Recently, Rwanda is among sub-Sahara African countries in which the prevalence of malaria is high. The Ruhuha Sector in Rwanda is one area burdened by malaria prevalence, with an estimated slide positivity rate of 5%.The area is located in Bugesera District of the Eastern Province, household survey results conducted in Ruhuha classify it as hypo-endemic for malaria, with cases clustered around marshlands. Individuals from households with high socioeconomic status have a lower risk of contracting malaria(2).
However, the Rwanda HMIS of 2012 revealed that the Eastern and Southern Province of Rwanda are the areas burdened by malaria morbidity and mortality where Bugesera District is one of the areas of high risk. On the other hand Gisagara District was the most affected area of malaria in the Southern Province. Thus, both districts share some characteristics such as geographical location that are bordering Burundi.

The research question of the study is as follows:

- What is the prevalence of malaria in Gisagara and Bugesera Districts?
- Why Gisagara District of the Southern Province and Bugesera District of the Eastern Province are the most at high risk for malaria?
- What are the associated factors with malaria in those Districts?

1.3 Study objectives

1.3.1. Main objectives

To analyse the risk factors of malaria in Gisagara and Bugesera Districts of Rwanda.

1.3.2. Specific objectives

1. To calculate the prevalence of malaria in Bugesera and Gisagara Districts.
2. To describe geographical and environmental conditions/status of Bugesera and Gisagara Districts favorable to the malaria mosquito development.
3. To identify the factors associated with malaria in Bugesera and Gisagara Districts.

1.4. Literature review

Globally, Malaria is among the public health issue in which policies aiming at tackling malaria should be prioritized by policy makers. During 2015, there was a reported incidence of 124 million of malaria cases, in 2016, 214 million cases observed(9) and 429 000 deaths attributed to malaria worldwide. A shared of 90% in WHO African region, 7% South Eastern in the Asia and 2% Eastern Mediterranean(10).

Therefore, according to the World Health Organization (WHO) the estimates of 3.2 billion people are at risk (11).Availability of public health information related to malaria has been used to put in place control measures with the high burden reversed between 2005 and 2015; the incidence of malaria declines of 35% and mortality related to malaria by 67% .Those figures are based in all age groups, in children aged under 5 years by 65% all of these figures indicates efforts made to reduce morbidity and mortality of malaria (11,12). In 2014, there was an estimate of 3.3 billion of people at risk, 214 million cases of malaria and 438,000 deaths (12,13).

In developed countries like in developing countries malaria is still a major public health problem. In the United Kingdom (UK) one of the developed country, an annual report of 1500 malaria cases per year as an imported malaria and incidence is said to be attributed to the people returning from their countries of endemic areas(14).

Malaria is a parasitic disease present in China like other developing countries(1,15). Many efforts on how to control the disease have been planned and implemented over the past decades, therefore, malaria cases in China have decreased from 61,204 malaria cases in 2006 to 14,278 malaria cases in 2009 (15). Thus, public health protection measures like National Malaria Elimination Program (NMEP) in 2010 where the government targeted to eliminate malaria in the most areas except the Yunnan-Myanmar border by 2015 thereafter the complete elimination in China by 2020(15).

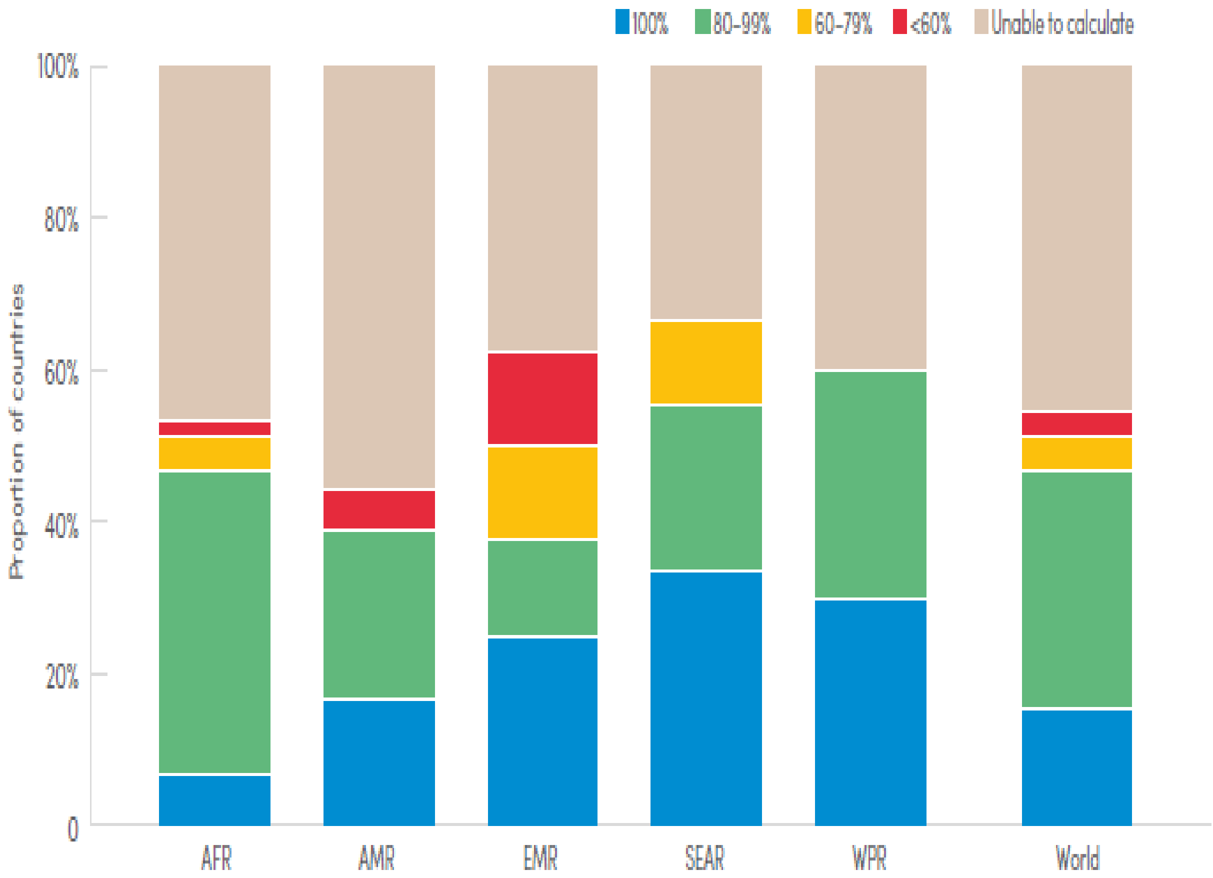
Spain was among countries with malaria as an endemic disease counting many cases throughout the year(16). During twentieth century, public health control measures such as sanitation and water supply implicating the improvement of socio-economic status involved the control of vectors and malaria transmission mode captured and control of the disease achieved(16).

Therefore, in 1964 malaria was declared to be eliminated across the country(16).Although, there was continuous information report on malaria to the Spanish Epidemiological Surveillance Network. The management of data is done by the National Centre for Epidemiology in the Carlos III Health Institute(16).

Data reporting system indicates that at least 10,000 malaria cases found through the years since elimination(16). It indicates that malaria is the most imported disease in Spain, such that the definition of the disease confirmed in those with history of travel in endemic regions, however, reports shown malaria cases in which a history of travel to an endemic zone was not there. Despite the investigation carried out, there was unable to identify the origin of the disease.

In 1961, it was the last and recent malaria case of autochthonous occurred in Spain(16). Since then there have been two reported cases of introduced malaria(16,17). In neither case was there a history of travel to region of risk, nor did the patients live in closely to the international airports. Other possible methods of infection were ruled out (history of surgery, invasive procedures or blood transfusions). The first case reported in September 2010 (16).

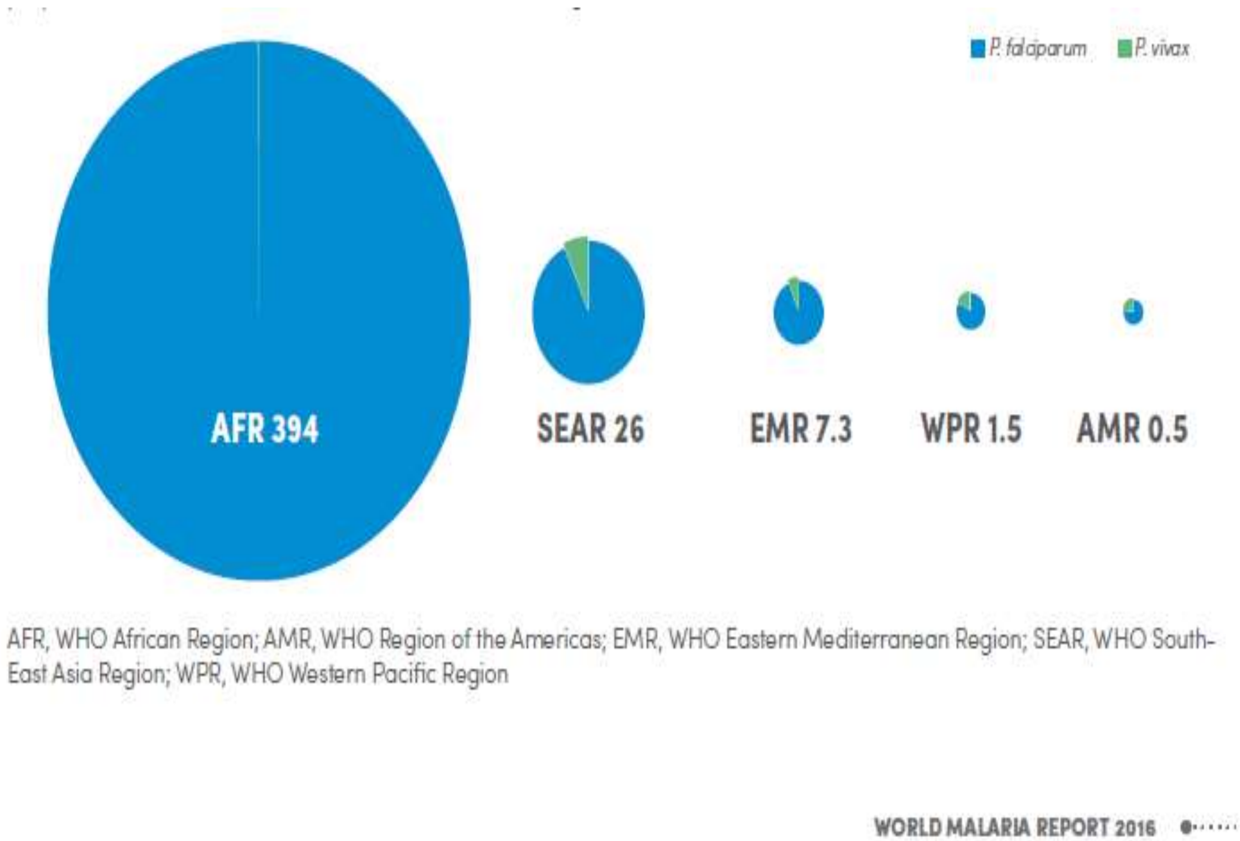
Figure 1. Health Facility reporting rates by WHO region, 2015



AFR, WHO African Region; AMR, WHO Region of the Americas; EMR, WHO Eastern Mediterranean Region; SEAR, WHO South-East Asia Region; WPR, WHO Western Pacific Region

Source: National malaria control programme reports, WHO report 2016.

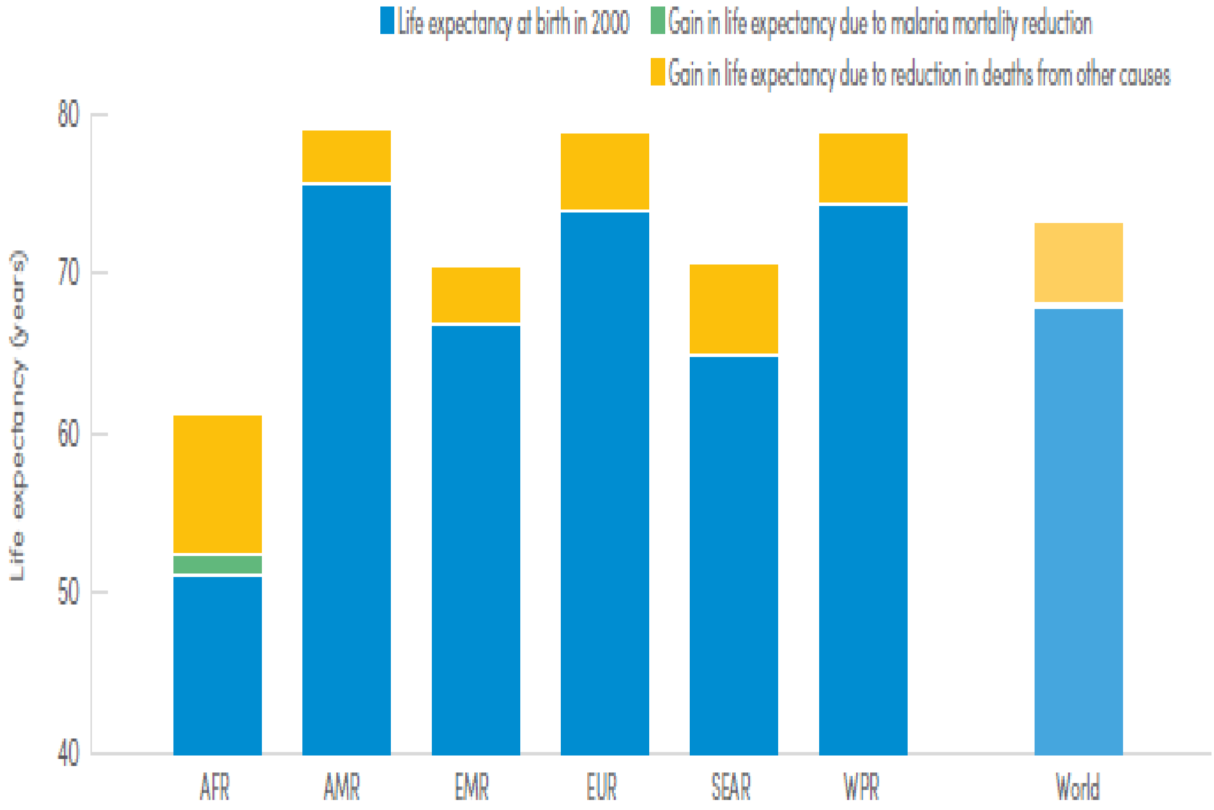
Figure 2. Estimated malaria deaths (thousands) by WHO region, 2015



An improved step towards in reducing malaria morbidity and mortality worldwide have been put in place and significantly improved. Worldwide, mortality rate reduced by 60% between 2000 and 2014, this could be referred to the possible attributable factors such as **case report system strengthening increased funding**, **improved surveillance** and **case-management**, and **scale-up of interventions**(18). Asia Pacific area, malaria deaths have declined by 86 %, the figure is defined by the efforts made in those countries not only in national program also supported by individual effort(18,19). For instance, 86% malaria cases reduced between 2000 and 2014 in Philippines and the figure of one-third of provinces having eradicated malaria as of 2013(18). 99% malaria cases have declined in Bhutan between 2000 and 2014, where there were 19 confirmed malaria cases only in 2014(18). Since in 2012, there was no malaria case reported in Sri Lanka by local reporting system (18).

With such improvement, longtime and short-time plan includes national or subnational malaria eradication goals. As well as global and regional strategic support plan for these efforts is growing, based resources by the World Health Organization's (WHO) new Global Technical Strategy for Malaria 2016–2030(18) and Strategy for Malaria Elimination in the Greater Mekong Sub region 2015–2030(18).

Figure 3. Gain in life expectancy in malaria endemic countries, 2000-2015



AFR, WHO African Region; AMR, WHO Region of the Americas; EMR, WHO Eastern Mediterranean Region; EUR, WHO European Region; SEAR, WHO South-East Asia Region; WPR, WHO Western Pacific Region

Source: WHO estimates.

To date, only a few low- and middle-income countries (LMIC) are on track toward malaria elimination. Mauritius, for example, is the only country in Sub-Saharan Africa that has successfully eliminated malaria. whereas Algeria was requesting a free malaria case certificate from the World Health Organization after the Second Global Forum for malaria elimination held in Costa Rica, 2018. This lag in progress toward malaria elimination is partly explained by fragile national health systems and the limited capacity of countries to adequately meet the health care needs of their population (2,6).

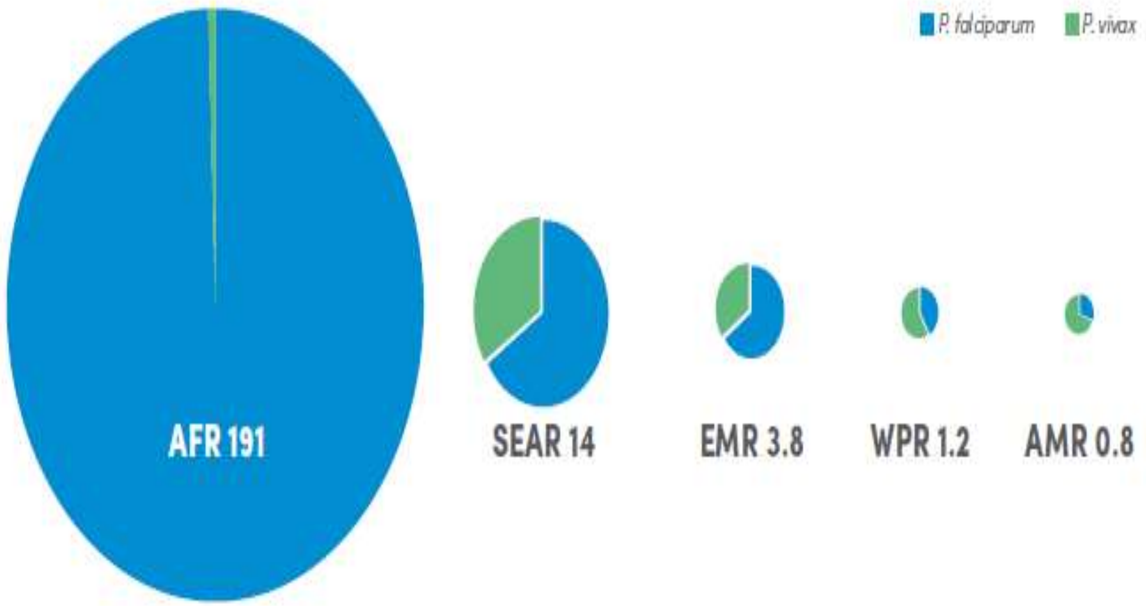
Countries placed in North Africa is densely populated alongside the Mediterranean and Moroccan coast; thus, the majority of these areas do not support stable Plasmodium falciparum transmission as defined through the fuzzy climate suitability model (figure 1).

In brief, the WHO Regional Offices covering these areas reported no cases of death due to malaria during throughout 1995 period. Countries like (Algeria, Egypt, Libyan Arab Jamahiriya, Morocco, and Tunisia) reportedly not considered as countries with the analysis of malaria disease burden in Africa (12).

The countries geographically placed in southern Africa have historically easily supported transmission of malaria within well-defined ecological boundaries. These boundaries are best defined from the fuzzy climate model among regions with a suitability index of >0.5. For many years countries placed in southern Africa have mounted rigorous malaria control strategies, involving active case detection, mass drug administration and, most significantly, aggressive vector control through residual house spraying.

These combined strategies have been successful in reducing the basic reproduction rate of infection and disease incidence(12).

Figure 4. Estimated malaria cases (millions) by WHO region, 2015



AFR, WHO African Region; AMR, WHO Region of the Americas; EMR, WHO Eastern Mediterranean Region; SEAR, WHO South-East Asia Region; WPR, WHO Western Pacific Region

Source: WHO report, 2016.

Figure 5. Estimated country shares (a) total malaria cases and (b) P. malaria vivax cases, 2015

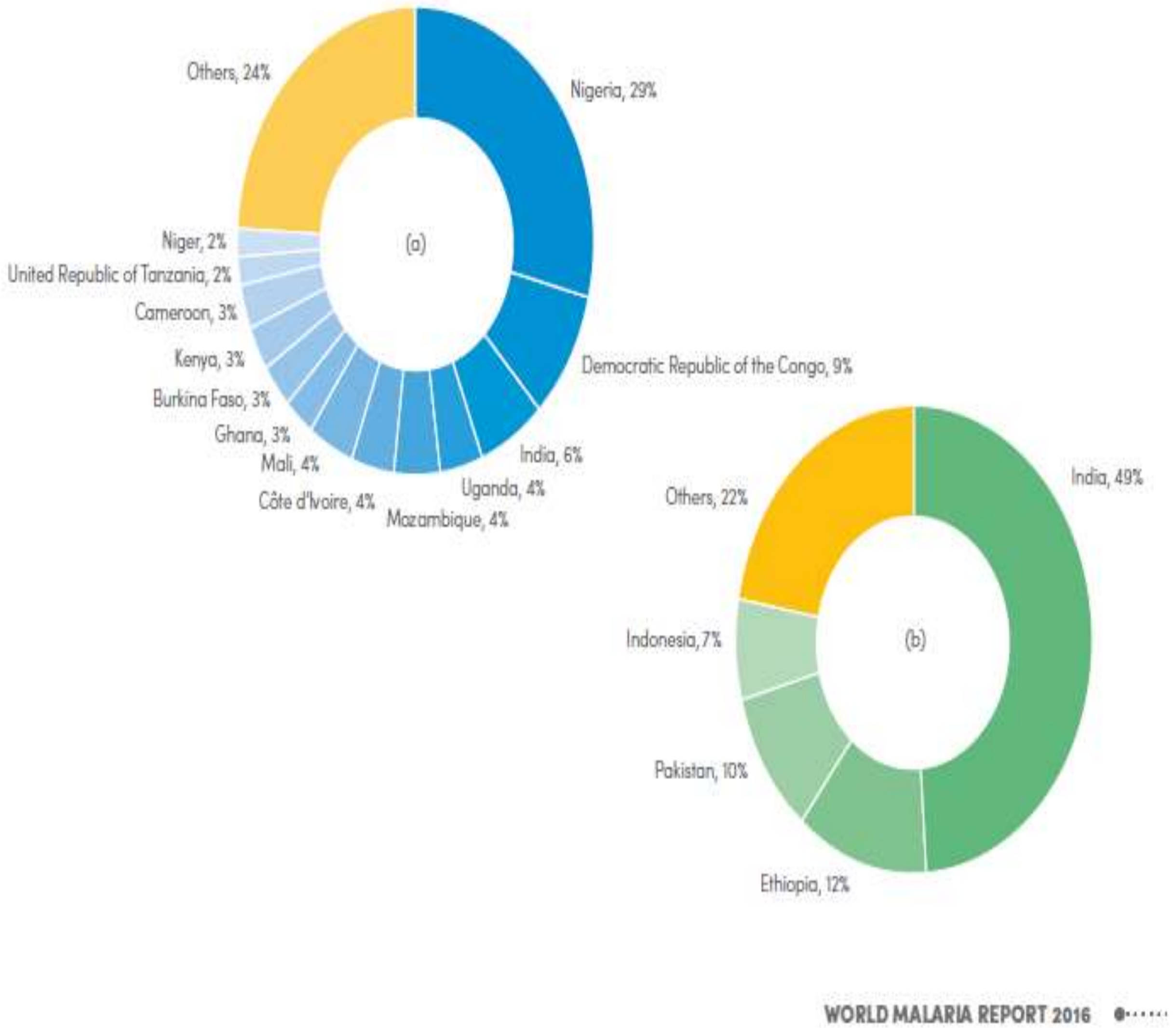
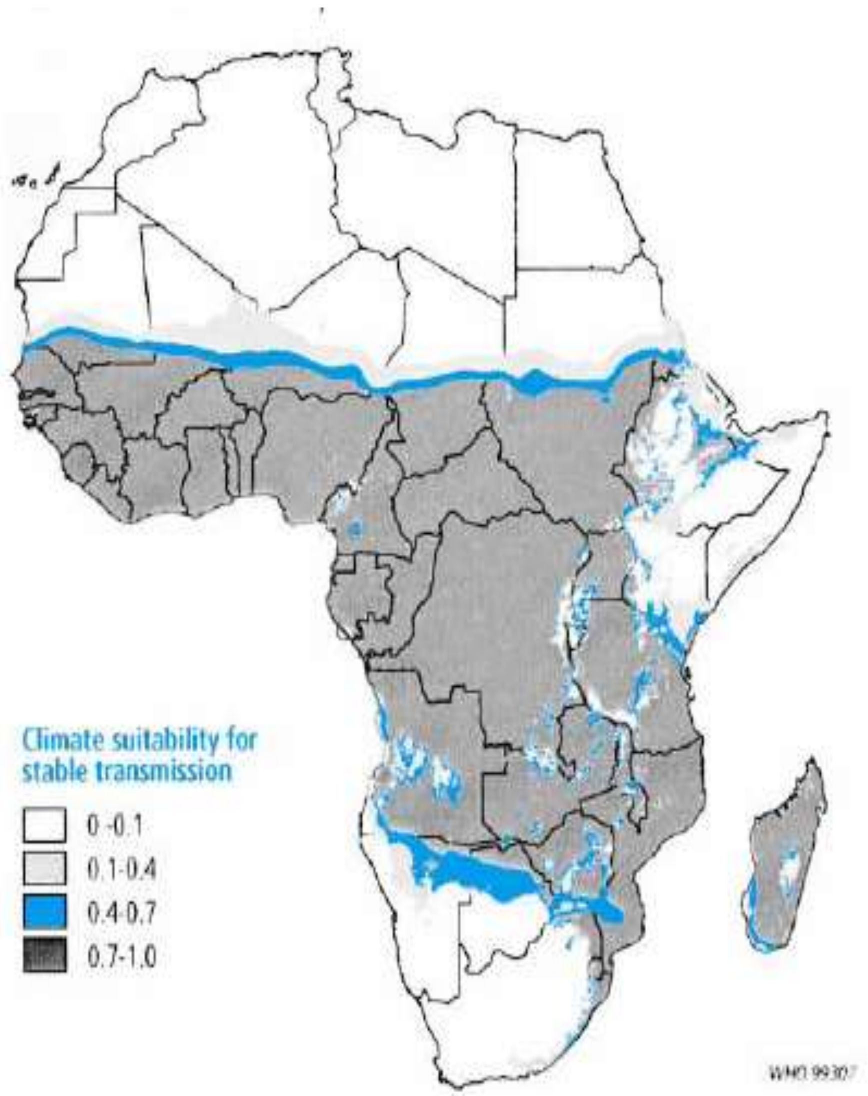


Figure 6. Climate suitability model for Africa derived using fuzzy probability



Regions in dark grey are very suitable for stable Plasmodium falciparum transmission and regions in white are highly unsuitable for stable transmission(12). Map courtesy of MARA (Mapping Malaria Risk in Africa International Collaboration).

As there is a remarquable decline in burden of malaria there has been a renewed focus on low-density chronic infections(20). Several and current studies identified a significant burden in infants(20), in school aged children(13,20), pregnant women(20), and non-pregnant adults(20).

Table 1. Population and mortality estimates for the interpolated distribution of the people according to classification of transmission risk(12)

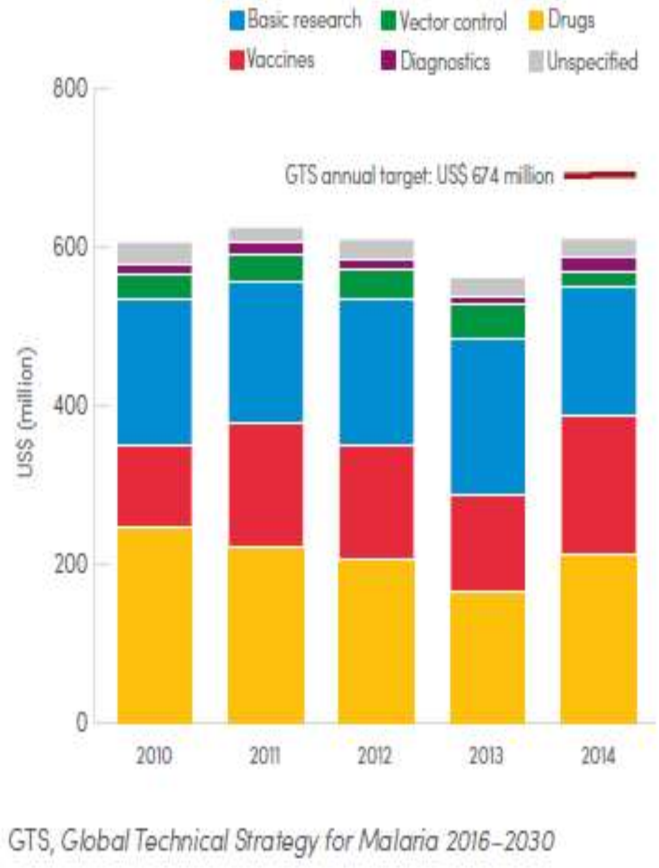
	African population exposed to different malaria risks (excluding southern and northern Africa)			Southern African population	
	0 climate suitability: No malaria risk	>0 and <0.2 climate suitability: Epidemic malaria risk[a]	⩾0.2 climate suitability: Stable transmission	<0.5 climate suitability: No malaria risk	⩾0.5 climate suitability: Malaria risk area
Population aged 0–4 years	4 609 524	9 850 391	81 429 978	5 504 839	3 025 494
Median mortality rate per 1000 population	–	NA	9.4 (7.1, 12.4)[b]	–	0.11 (0.02, 0.20)
Estimated numbers of deaths in 1995	0	NA	765 442 (578 153–1 009 732)	0	333 (61–605)
Population aged 5–9 years	3 770 381	8 174 807	67 032 624	4 893 730	2 602 153
Median mortality rate per 1000 population	–	NA	2.17 (1.64, 2.86)	–	0.11 (0.02, 0.20)
Estimated numbers of deaths in 1995	0	NA	145 461 (109 934–191 713)	0	286 (52–520)
Population aged 10–14 years	3 097 257	6 906 370	56 360 964	4 535 489	2 359 704
Median mortality rate per 1000 population	–	NA	0.80 (0.61, 1.06)	–	0.11 (0.02, 0.20)
Estimated numbers of deaths in 1995	0	NA	45 089 (34 380–59 743)	0	260 (47–472)
Population aged >15 years	13 329 952	29 639 097	242 110 974	24 179 130	11 422 561
Median mortality rate per 1000 population	–	NA	0.13 (0.09, 0.17)	–	0.11 (0.02, 0.20)
Estimated numbers of deaths in 1995	0	NA	31 474 (21 790–41 159)	0	1 256 (228–2285)
Total population in 1995	24 807 114	54 570 668	446 934 540	39 113 188	19 409 912
Total deaths in 1995 [non-epidemic year]	0	NA	987 466 (744 257–1 302 347)	0	2 135 (389–3882)

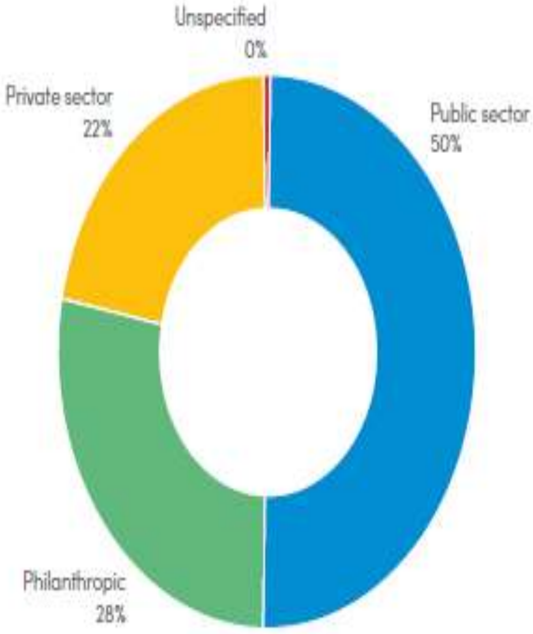
[a] No reliable estimates of age-specific malaria mortality during malaria epidemics are available.

[b] Figures in parentheses are the interquartile range.

Figure 7. Funding for malaria-related research development, 2010-2014

Figure 7.1: Source of funding for malaria-And malaria-related research





Source: World WHO report, 2016.

Rwanda decreased malaria morbidity rate from 73.5% in 2002 to 7% in 2012 in children under five(11). 2005 , malaria was ranked as number one killer and in 2008 ranked as number three in children under five as well the dropped to number 11 in 2011 (11). Therefore, the government plan to pre-eradicate malaria levels by 2018(7,8,11).

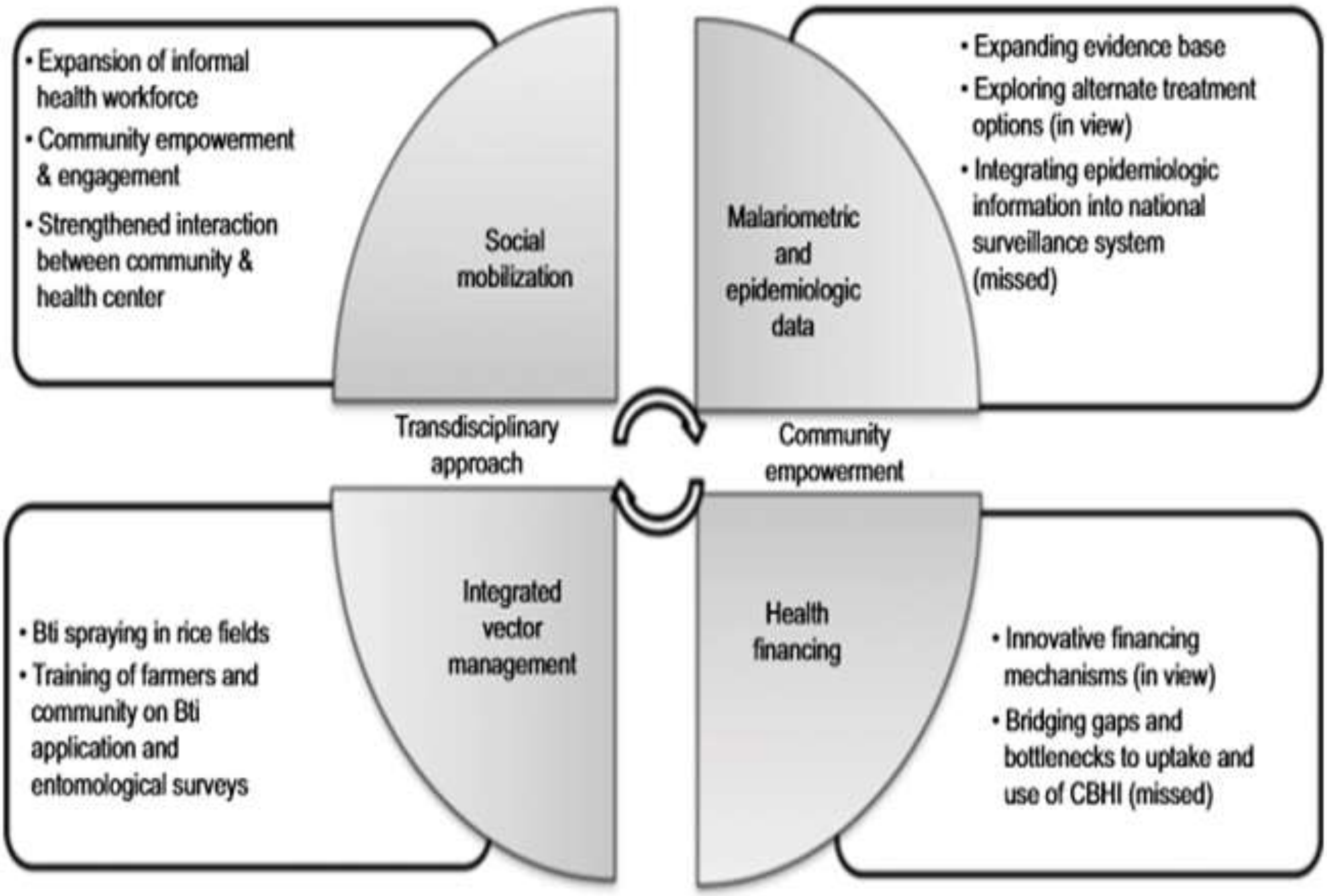
In 2012, a 4-year community-based project tagged Malaria Elimination Program for Ruhuha (MEPR) was launched in Ruhuha. The project team comprised of two change management specialists, four doctoral students with two supervisors each, and a project manager.

The multi-disciplinary intervention comprised of four pillars, namely:

- Behavioral science for social mobilization toward malaria elimination;
- Biomedical science for epidemiological studies and the generation of malariometric data;
- Medical entomology focusing on integrated vector management;
- Health financing which involved an assessment of community attitudes to investing in malaria elimination(2).

Supportive treatments such as exchange transfusions and erythrocyte apheresis are a matter of controversy and their use is guided by national or local practices (4).

Figure 8. Health systems strengthening effects of the different MEPR pillars in Rwanda



1.4.1. Associated risk factors linked to malaria.

Trends in malaria incidence could be attributed to the various determinants including climatic, environmental, and socioeconomic factors(17).

Climate, land-use/land cover, irrigation usage, topography and soil type are the environmental factors contributing to determine the type, distribution and density of mosquito vectors and disease incidence in which favorable conditions of mosquito development are provided(17).

Results on the study done on the effects on air temperature and rainfall on incidence of malaria provide evidence that both air temperature and rainfall modulate the risk of malaria occurrence in Rwanda and Uganda(17).

The selection criteria were based on historical and current studies that explore the reasons behind malaria transmission and declines seen, as well as the availability of datasets. Climate changes, especially in temperature, are often considered to have an effect on malaria transmission(2,4).

Economic development (represented by gross domestic product (GDP) per capita here) is linked to the general levels of poverty, which have a significant association with malaria prevalence. Better nutrition, living environments and healthcare access are attributed to the rich people than to poor people, thus, providing barriers to the establishment and maintenance of malaria transmission(8).

1.4.2. Interventions

Malaria elimination will require targeting the parasite (plasmodium), the vector (mosquito) and most importantly the human host, thus, community participation in malaria control is perceived as a key factor (3).

The study revealed that controls measures including the use of mosquito nets, especially ITNs and LLINs only are not sufficient. Supplement of education, consistent use of ITNs and LLINs, indoor residual spraying (IRS), education of practicing safe living habits like reducing outdoor activities during peak biting mosquito hours contribute to decrease the malaria burden.

The increased level of under-developed countries shown a significant challenge in decreasing malaria morbidity and mortality explained by a quarter of population living under the poverty line. The risk map plays an important role in identifying the highly geographical areas at risk and through police makers allocate resources and appropriate interventions(5).

1.5. Conceptual framework

The **exposure factors** known as the “regressors, manipulated variables, explanatory variables, independent variables or input variables” are grouped into the following:

Macro-factors:

Polices,
Government investment,
Engeneering projects.

Individual and household factors:

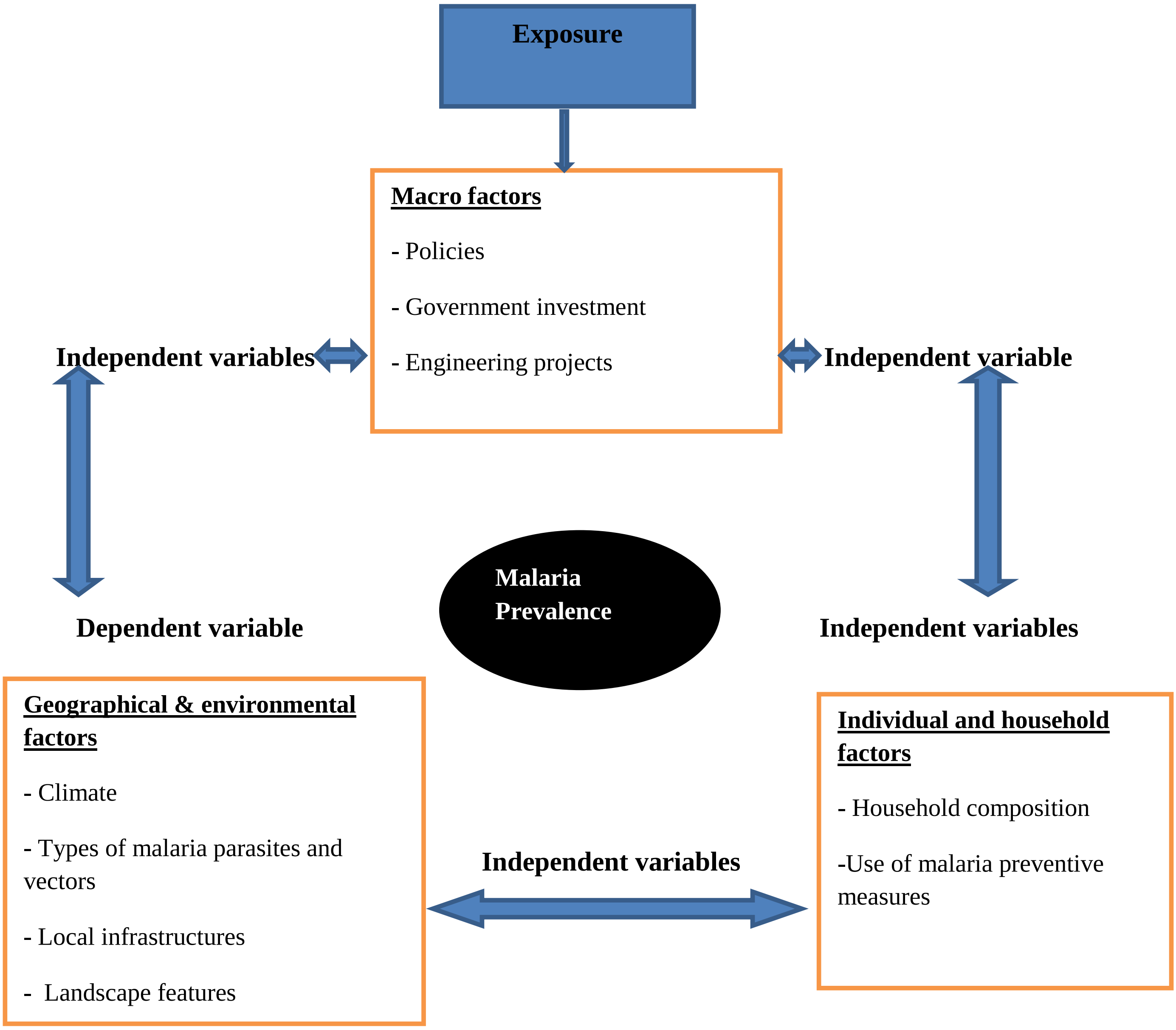
Household composition,
Use of malaria preventive measures.

Geographical and Environmental factors:

Climate,
Types of malaria parasites and vectors,
Local infrastructures,
Landscape features,
Rural vs Urban areas.

The dependent variable known as the outcome is **malaria prevalence**, as shown in Figure 9.

Figure 9. Conceptual framework



CHAPTER TWO: METHODS AND MATERIALS

2.1. Study setting

Rwanda is located in East Africa with a population of about 10.5 million. Rwanda is a land locked country of 26,338 km2. Rwanda has Kigali city and 4 provinces. There are 30 Districts, 416 Sectors, 2,148 Cells, and 14,837 Villages in Rwanda .The Bugesera District and Gisagara District of Rwanda are located within Rwanda, sharing boundaries with Burundi. In Rwanda, the health system includes the followings main levels: Community, Health Center, District Hospital, Provincial and Referal (Teaching Hospitals). Community Health Workers (CHWs) provide household level health education, case finding for acute and chronic illness, Integrated Community Case Management, ICCM (including diagnosis and treatment of pneumonia, diarrhea, and malaria), female contraception, and linkage to health facilities for prenatal care, deliveries, and other medical services. Each of the health centers serve a catchment area of approximately 20,000–30,000 people and are staffed by general nurses who provide basic diagnostics, outpatient acute services, family planning, prenatal care, and routine deliveries. The average walking distance from households to the nearest health facility is estimated at just over an hour in most districts. Reflecting national standards, district hospitals both Gakoma and Kibilizi all located in Gisagara District and Nyamata District Hospital is located in Bugesera District are staffed by general practitioners, allied health professionals and nurses who provide secondary care for advanced or inpatient care for patients referred from health centers, including comprehensive obstetric emergencies requiring cesarean section, neonatal care, and inpatient treatment for severe childhood illness and severe malnutrition. Provincial hospitals are staffed with some specialists, general practioners, allied health professionals and nurses in charges of providing health package of provincial hospitals. Referral hospitals are equipped with not only specialist staff and softiqueted equipment such as Computed Tomography, Magnetic Resonance Imaging and other for advanced diagnosis and interventions purpose.

2.2. Study design

The study design was a quantitative, analytical and cross-sectional survey. The study used a secondary data from the Rwanda Demographic Health Survey (RDHS) 2014/2015 to compare the risk factors of malaria in Bugesera and Gisagara Districts of Rwanda.

2.3. Specific objectives achievement

To calculate the prevalence of malaria in Bugesera and Gisagara Districts: This objective was achieved by computing (addition) the old and new cases of malaria in each district divided by the total population of the study in each district.

To describe geographical and environmental condition/status of Bugesera and Gisagara Districts favorable to the mosquito development: This objective was achieved by analyzing the level of significant by using statistical test in environmental and geographical variables of both Gisagara and Bugesera Districts.

To identify the factors associated with malaria in Bugesera and Gisagara Districts: This objective was achieved by analyzing and computing the dependents variables linked to malaria in both districts by both bivariate and multivariate analyses.

Study variables

Outcomes variable: Outcome variable is malaria prevalence

Independent variables:

- Household possession of mosquito nets,
- Use of insecticide-treated net (ITN),
- Use of mosquito nets by persons in the household,
- Use of ITNs,
- Owns land used for agriculture,
- Owns livestock Herds or farm animals,
- Having radio,
- House has separate room used as Kitchen,
- Having bank account,
- Having mobile phone,
- Use of mosquito nets,
- Coverage of malaria testing,
- Macro-factors,
- Geographical and environmental factors,
- Individual and household factors,

Analysis plan

The extracted variables and values of interest into an excel sheet then separated them into Bugesera and Gisagara Districts, Then after, we renamed some variables and proceed with analysis of malaria status as numeric data. STATA 13.0 was used to displace results according to significance of comparative risk factors.

Descriptive analysis for malaria status was computed for the two districts as a whole. Linear and multiple linear regressions were used to show comparative risk factors for malaria morbidity in both Bugesera and Gisagara Districts of Rwanda. Analysis was based at a significance level of 0.05 and 80% power. The first step was to group the measure that defines malaria cases after defining them. After this, we determined the percentages and compared malaria cases and risk factors in both Bugesera and Gisagara Districts of Rwanda.

2.4. Study population

The target population was the all people of Bugesera and Gisagara Districts of Rwanda who participated in a survey of 2014/2015.

2.4.1. Sample size calculation

This is a cross-sectional survey using secondary data; the sample size is the total population filled the questionnaire of the Rwanda Demographic Health Survey of 2014/2015 in Gisagara and Bugesera Districts.

2.4.2. Sampling techniques

The study used a RDHS data of 2014/2015 whereby all population stayed in their home in the evening preceding the interview were considered as the sample size of the study. The sample for the 2014/2015RDHS was designed to provide population and health indicator estimates for the country as a whole and for urban and rural areas in particular. A representative sample of 13,497 was selected for the 2014/2015 RDHS. The sample was selected in two stages.

The first stage consisted of 492 selected villages with probability proportional to the village size (also known as clusters or enumeration areas). The second phase of sampling consisted of a complete mapping and listing of all households in the selected villages. The obtained lists of households served as the sampling frame for the second stage of sample selection. Households were systematically selected from those lists for participation in the survey (21).The 2015 RDHS was the sixth national health survey for which data collection was conducted from November 9, 2014 to April 8, 2015. All of the 492 clusters selected for the sample were surveyed. A representative's sample size of 741 was selected in both Districts (Bugesera and Gisagara) as the households who accepted to respond the questions regarding to Malaria in 2014/2015 RDHS questionnaire, with a representative total sample size of 387 in Gisagara District and 354 in Bugesera District among the whole population of 12,699 who completed the household questionnaire in whole country for the 2014-2015 RDHS.

2.4.3. Data collection procedures

Rwanda Demographic Health Survey of November 9th/2014 to April 8th/2015 was used for secondary data analysis. The first step was the registration and application to RDHS datasets. The researcher made the request to use the datasets on June 11th 2019 and was approved on June 11th 2019 of both Gisagara and Bugesera Districts.

The researcher agreed the terms and conditions in using DHS data set such that it is not allowed to make any effort for identifying respondents, households addresses or sample communities in which the Institutional Review Board approved procedures for DHS public use datasets. The second step was to download the original datasets from RDHS 2014/2015, Datasets of Gisagara and Bugesera Districts was extracted from the RDHS 2014/15 datasets from the datasets of Rwanda and used for obtaining and describing the comparative risk factors of malaria and characteristics of the population within the selected areas of the study. Therefore, the original data to compute the malaria prevalence were derived from the Malaria section of the Questionnaire used in DHS 2014/2015.

2.5. Materials

2.5.1. Study tools

The data used to compute the malaria cases were derived from the malaria history Questionnaire used in RDHS 2014/2015. Data will be analyzed using STATA version 13.0.

2.6. Policy implications

The results will be used to strengthen existing knowledge on Risk factors and prevalence of malaria in Rwanda focusing on both Gisagara and Bugesera Districts under the study, hence contributing in malaria cases policy reforms focusing on contextual risk factors towards the achievement of the sustainable development goals by 2030. Findings from the study will be shared with the School of Public Health University of Rwanda and later will be published in a peer reviewed journals.

2.7. Ethical considerations

Confidentiality: The personal details of participants were not requested to the RDHS team when applying for the dataset. The researchers that participated in the RDHS 2014/2015 will not participate in the present study and we will not make any efforts to identify the study participants. The study data will be analyzed anonymously.

Informed consent/Assent form: This study had no direct contact with humans or with any identifiable information/parts of human beings. The researcher found no need for an informed consent for participation; hence no informed consent will be needed.

CHAPTER THREE: RESULTS

3.1. Socio-economic and demographic characteristics of the study population.

The results from **Table 2** printed out the major socio-economics characteristics in the regions of study whereas the majority of the interviewed heads of household in the study areas were men at level of 67.96% in Gisagara District and 82.49% in Bugesera District. The higher representative heads of household were found in Bugesera District, as it was found, there were 32.04% women's heads of household in that District. At least all interviewed heads of household were in category of youth; the majority among them had the years varying between 21 and 60 with the total rate of 94.02%. The higher number of interviewed persons in Gisagara District was in an average years of 41-60 and 21-40 years with the rate of 47.55% and 44.44% respectively while in Bugesera District, the higher number of interviewed heads of household was in category of 21-40 years with a rate of 67.8%. The results showing that the households' respondents who had at least 20 years also were at low level with a rate of 0.4% and among them no body found in Gisagara District while there were at least 0.78% in total head of household interviewed in Bugesera District, the same as for the heads of household with age greater than 80 years, there were nobody interviewed in Bugesera District while there were 1.03% of head of household interviewed in Gisagara district.

The result also showed that, the majority of interviewed head of households did not have any education level at least 9/10 attend either primary school only, whereas **44.9%** and **40%** attend at least primary school in Gisagara and Bugesera District respectively. The results showed a low proportion among the people who had the abilities to attend the higher school with the rate of 0.26% in Gisagara whereas they were 0.85% in Bugesera Districts. Only 34.37% and 34.62% of heads of household were married in Gisagara and Bugesera District respectively. The results showed that the majority were the heads of household who were never married with a rate of 40.43% and 29.81% in Gisagara and Bugesera District respectively.

The results showed that the majority of the heads of the household were in poor category in Gisagara District. Among all interviewed heads of Household in Gisagara District, 53.75% were poorest while 20.67% were poor. Contrary, in Bugesera District the majority of interviewed heads of household were in middle and richer category with a rate of 25.42% and 23.45% respectively.

The higher level of poverty found while analyzing this data may higher related with the fact that the majority of households especially those visited in Gisagara District didn't have enough agriculture land size, owns their livestock's nor having the ability to save some money on bank account. The results showed that the among all interviewed households 21.25% didn't own any land, and among those who had land 38.75% had the shortage land varying between 0.1 up to 1ha, in the same district. Majority, 54.25% didn't own the livestock and many of them (62.27%) didn't have the bank account. Comparatively to those interviewed households of Bugesera District, 31.93% did not own any proportion of land and among those who had the land, 38.98% had the shortage land varying between 0-1ha, 39.27% did not have any livestock while 45.48% among of them don't have a bank account. Cooking food is usually the activity performed by women in rural areas as the same as in town. As it was found, the majority of households visited in Gisagara District cook their foods in the sleeping house (62.53%) comparatively to those of Bugesera District whereas the majority (69.77%) preparing the foods in the house separated with the main sleeping houses. The cooking place maybe the greatest factor for malaria infection among the household's members of Bugesera District, as the major of the them (69.77%) move from one house to another for the food cooking, and some of them (21.19%) using outdoor for the food cooking.

Table 2. Socio-economic and demographic characteristics of the study population.

Variables		Gisagara (N=387) Frequency	Gisagara (N=387) Percent	Bugesera (N=354) Frequency	Bugesera (N=354) Percent
Sex	Male	263	67.96	292	82.49
	Female	124	32.04	62	17.51
Age (in years)	<20	3	0.78	0	0
	21-40	172	44.44	240	67.8
	41-60	184	47.55	98	27.68
	61-80	24	6.2	16	4.52
	>80	4	1.03	0	0
Education	No education, preschool	186	48.06	166	46.89
	Primary	174	44.96	142	40.11
	Secondary	26	6.72	43	12.15
	Higher	1	0.26	3	0.85
Marital status	Never married	95	40.43	62	29.81
	Married	81	34.47	72	34.62
	Living together	34	14.47	52	25
	Widowed	9	3.83	10	4.81
	Divorced	1	0.43	5	2.4
	Not living together	15	6.38	7	3.37
Wealth index	Poorest	208	53.75	57	16.1
	Poorer	80	20.67	59	16.67
	Middle	37	9.56	90	25.42
	Richer	35	9.04	83	23.45
	Richest	27	6.98	65	18.36
Place of cooking	In the house	242	62.53	32	9.04
	In a separate building	122	31.52	247	69.77
	Outdoors	23	5.94	75	21.19
Household has separate room used as Kitchen	No	51	21.25	13	40.63
	Yes	189	78.75	19	59.38
Owns land usable for Agriculture	No	107	27.65	113	31.92
	Yes	280	72.35	241	68.08
Agriculture land size (in hectares)	0	134	38.73	138	38.98
	1-5	45	13.01	45	12.71
	5-10	32	9.25	39	11.02
	Above 10	135	39.02	132	37.29
Owns livestock herds or farm animals	No	210	54.26	139	39.27
	Yes	177	45.74	215	60.73
Having Bank Account	No	241	62.27	161	45.48
	Yes	146	37.73	193	54.52

3.2. Prevalence of malaria in Bugesera and Gisagara Districts.

Table 3. Prevalence of malaria in Bugesera and Gisagara Districts.

The results of the study show that in Gisagara District the level of malaria prevalence is low compared to the level of malaria prevalence in Bugesera District. The figures of malaria prevalence are as follow 10.08% and 12.71% in Gisagara and Bugesera Districts respectively.

	Gisagara District		**Bugesera District**	
Results of Malaria tests	Frequency	Percentages (%)	Frequency	Percentages (%)
Negatives	348	89.92	309	87.29
Positives	39	**10.08**	45	**12.71**

3.3. Geographical and environmental status of Gisagara and Bugesera Districts.

In this study, it was found that, the majority of the households in Bugesera used the technological materials much more if compared with those of Gisagara District, 52.54% having and frequently listening to radio, 14.69% having and watching television while 74.58% using mobile phone to Gisagara District, 48.84% having and frequently listening to radio, 3.88% having and frequently watching television with 38.24% who had and used mobile phone.

The results from this survey printed out that majority of interviewed households living in rural areas at level of 86.05% and 85.03% in Gisagara and Bugesera Districts respectively, and 13.95% and 14.97% who lived in urban, this may the reason malaria found much more in those areas of study. There were still a higher number of people who took long journey within the year of 2014-2015 in order to reach the hospital in those areas of study. A higher number 46.40% in Gisagara District went from home up to nearly District Hospital or Health Center for interval length of 200-500m while in Bugesera District a higher number 49,68% of interviewed households went for length above 500m in order to reach a hospital or health center. A considerable households number went few time in order to reach the nearly hospital or health center in Gisagara District if compared with those of Bugesera District, the results showed that 29.07% among the interviewed heads of household take them length with were less than 200m while for those of Bugesera District were 9.03% only.

The majority of the households in Bugesera District were located in low altitude, whereas all of them 100% living in different agro-ecological zone with altitude under 1500m, 55.65% at altitudes of 1301-1400m and 44.35% at altitudes of 1501-1600m. Contrary to the households of Gisagara District, majority of those lived on higher altitudes whereas 57.11% lived on altitudes of 1501-1600 m, 20.16% lived on altitudes greater than 1601m with only few households 22.74% who lived on altitudes below 1500 m. According to geographical location, these two districts, are located near the long rivers (Akanyaru and Akagera rivers) of country pass through them before reaching abroad and became Nil. These two Districts were covered with several marshlands and swamps that were the suitable areas for the development of mosquitos. This is maybe also the reason by which Gisagara and Bugesera were two Districts with higher number of positive results tests of Malaria in the country. According to the results in **Table 4**; 4.39% households located in region with the altitude less than 1400m in Gisagara District while only 6.98% households located in region of altitudes of 1701-1800 m.

Table 4. Geographical and environmental status of Gisagara and Bugesera Districts.

Variables		Gisagara (N=387) Frequency	Gisagara (N=387) Percent	Bugesera (N=354) Frequency	Bugesera (N=354) Percent
Having a radio	No	198	51.16	168	47.46
	Yes	189	48.84	186	52.54
Having a Television	No	372	96.12	302	85.31
	Yes	15	3.88	52	14.69
Having a mobile	No	239	61.76	90	25.42
	Yes	148	38.24	264	74.58
Having mosquito bed net	No	42	10.85	42	11.86
	Yes	345	89.15	312	88.14
Type of Mosquito bed net used	Did not sleep under mosquito net	125	32.3	84	23.73
	Only treated Mosquito net	262	67.7	270	76.27
Person sleeping under the treated net	No	125	32.3	84	23.73
	Yes	262	67.7	270	76.27
Covered by health insurance	No	130	33.68	103	29.1
	Yes	256	66.32	251	70.9
HH Residence	Urban	54	13.95	53	14.97
	Rural	333	86.05	302	85.03
Distance from house (in meters)	>200	109	29.07	28	9.03
	200-500	174	46.4	128	41.29
	< 500	92	24.53	154	49.68
Altitudes (in meters)	1301-1400	17	4.39	197	55.65
	1401-1500	71	18.35	157	44.35
	1501-1600	221	57.11	0	0
	1601-1700	51	13.18	0	0
	1701-1800	27	6.98	0	0

3.4. Bivariate Analysis

3.4.1. Bivariate analysis of Malaria and socio-economic and demographic characteristics of the study population.

The results of the bivariate analysis of Malaria and socio-economic and demographic characteristics of the study population show that in Gisagara District , two variables including owns livestock herds or farm animals and having bank account were statistically significant with Malaria at a P-value of 0.02 and 0.04 respectively. For Bugesera District, none variable was statistically significant with malaria.

Table 5. Bivariate analysis of Malaria and socio-economic and demographic characteristics of the study population.

		Results of Malaria tests in percentage					
		Gisagara (N=387)			**Bugesera (N=354)**		
Variables		Positives N=39	Negatives N=348	P-Value	Positives N=45	Negatives N=309	P-Value
Sex	Male	64.10(25)	68.39(238)	0.586	88.89 (40)	81.55(252)	0.226
	Female	35.90 (14)	31.61(110)		11.11 (5)	18.45 (57)	
Age (in years)	<20	2.56 (1)	0.57 (2)		0.00 (0)	0.00 (0)	
	21-40	28.21 (11)	46.26(161)	0.128	64.44 (29)	68.28(211)	0.073
	41-60	58.97(23)	46.26 (161)		24.44 (11)	28.16 (87)	
	61-80	10.26(4)	5.75 (20)		11.11 (5)	3.56 (11)	
	>80	0.00 (0)	1.15 (4)		0.00 (0)	0.00(0)	
Education	no education, preschool	56.41 (22)	47.13 (164)		62.22 (28)	44.66 (138)	
	Primary	35.90(14)	45.98(160)	0.661	33.33 (15)	41.10 (127)	0.105
	Secondary	7.69 (3)	6.61(23)		4.44(2)	13.27 (41)	
	Higher	0.00(0)	0.29(1)		0.00 (0)	0.97(3)	
Marital Status	Never Married	72.22 (13)	37.79 (82)		47.06 (8)	28.27(54)	
	Married	5.56 (1)	36.87(80)		23.53 (4)	35.60 (68)	
	Living together	16.67 (3)	14.29 (31)		29.41(5)	24.61 (47)	
	Widowed	0.00 (0)	4.15 (9)	0.062	0.00 (0)	5.24(10)	0.466
	Divorced	0.00 (0)	0.46 (1)		0.00 (0)	2.62 (5)	
	Not living together	5.56(1)	6.45 (14)		0.00 (0)	3.66 (7)	
Weath Index	Poorest	74.36 (29)	51.44 (179)		28.89 (13)	14.24 (44)	
	Poorer	15.38(6)	21.26 (74)		15.56 (7)	16.83 (52)	
	Middle	0.00 (0)	10.63 (37)	0.058	26.67 (12)	25.24 (78)	0.112

	Richer	5.13 (2)	9.48 (33)		17.78 (8)	24.27 (75)	
	Richest	5.13 (2)	7.18(25)		11.11 (5)	19.42 (60)	
Cooking areas	In the house	66.67 (26)	62.07 (216)		13.33 (6)	8.41 (26)	
	In separate building	28.21 (11)	31.90 (111)	0.853	60.00 (27)	71.20 (220)	0.288
	Outdoors	5.13 (2)	6.03 (21)		26.67 (12)	20.39 (63)	
House has separate room used as Kitchen	No	19.23 (5)	21.50 (46)	0.79	33.33(2)	42.31 (11)	0.687
	Yes	80.77(21)	78.50(168)		66.67(4)	57.69 (15)	
Owns land used for agriculture	No	33.33 (13)	27.01 (94)	0.403	31.11 (14)	32.04 (99)	0.901
	Yes	66.67 (26)	72.99 (254)		68.89 (31)	67.96(210)	
Agriculture land Size(in hectares)	0	42.86 (15)	38.26 (119)		40.00(18)	40.00 (120)	
	5-Jan	5.71(2)	13.83 (43)		20.00(9)	11.65 (36)	
	10-May	2.86 (1)	9.87 (31)	0.222	22.22 (1)	12.30 (38)	0.122
	Above 10	48.57(17)	37.94 (118)		37.78(17)	37.22(115)	
Owns livestock Herds or farm animals	No	71.79(28)	52.30 (182)	0.02**	33.33(15)	40.13 (124)	0.383
	Yes	28.215 (11)	47.705(166)		66.67(30)	59.87 (185)	
Having Bank Account	No	76.92 (30)	60.63 (211)	0.047**	51.11 (23)	44.66 (139)	0.417
	Yes	23.08 (9)	39.37 (137)		48.89(22)	55.34 (171)	

3.4.2. Bivariate analysis of Malaria and geographical and environmental status of Gisagara and Bugesera Districts.

The results show that for Gisagara District variables such as having radio, having mobile phone, having mosquito bed net, type of mosquito bed net used, person sleeping under the treated net, covered by health insurance were statistically significant.

For Bugesera District, three variables were statistically significant. Those variables include; type of mosquito bed net used, person sleeping under the treated net and altitudes.

Table 6. Bivariate analysis of malaria and Geographical and environmental status of Gisagara and Bugesera Districts

Results of malaria tests in percentages							
		Gisagara (N=387)			Bugesera (N=354)		
Variables		**Positives (N=39)**	**Negatives (N=348)**	**P-Value**	**Positives (N=45)**	**Negatives (N=309**	**P-Value**
Having a radio	No	71.79 (28)	48.85 (170)	0.007***	48.89 (22)	47.25 (146)	0.837
	Yes	28.21 (11)	51.15 (178)		51.11 (23)	52.75 (163)	
Having a Television	No	97.44 (38)	95.98 (334)	0.654	91.11 (41)	84.47 (261)	0.239
	Yes	2.56 (1)	4.02 (14)		8.89 (4)	15.53 (48)	
Having mobile Phone	No	76.92 (30)	60.06 (209)	0.04**	28.89 (13)	24.92 (77)	0.568
	Yes	23.08 (9)	39.94 (139)		71.11 (32)	75.08 (232)	
Having mosquito bed net	No	30.77 (12)	8.62 (30)	0.000***	20.00 (9)	10.68 (33)	0.071
	Yes	69.23 (27)	91.38 (318)		80.00 (36)	89.32 (276)	
Type of Mosquito bed net used	Did not sleep under mosquito net	56.41 (22)	29.60 (103)	0.001***	35.56 (16)	22.01 (68)	0.046**
	Only treated Mosquito net	43.59 (17)	70.40 (245)		64.44 (29)	77.99 (241)	
Person sleeping under the treated net	No	56.41 (22)	29.60 (103)	0.001***	35.56 (16)	22.01 (68)	0.046**
	Yes	43.59 (17)	70.40 (245)		64.44 (29)	77.99 (241)	
Covered by health insurance	No	64.10 (25)	30.26 (105)	0.000***	37.78 (17)	27.83 (86)	0.17
	Yes	39.50 (14)	69.74 (242)		62.22 (28)	72.17 (223)	
HH Residence	Urban	20.51 (8)	13.22 (46)	0.213	13.33 (6)	15.21 (47)	0.742
	Rural	79.49 (31)	86.78 (302)		86.67 (39)	84.79 (262)	
Distance from House (in meters)	>200	18.42 (7)	30.27 (102)		2.27 (1)	10.15 (27)	
	200-500	47.37 (18)	46.29 (156)	0.195	54.55 (24)	39.10 (104)	0.074
	< 500	34.21 (13)	23.44 (79)		43.18 (19)	50.75 (135)	
Altitudes (in meters)	1301-1400	7.69 (3)	4.02 (14)		75.56 (34)	52.75 (163)	
	1401-1500	20.51 (8)	18.10 (63)		24.44 (11)	47.25 (146)	
	1501-1500	66.67 (26)	56.03 (195)	0.147	0.00 (0)	0.00 (0)	0.004***
	1501-1600	2.56 (1)	14.37 (50)		0.00 (0)	0.00 (0)	
	1601-1700	2.56 (1)	7.47 (26)		0.00 (0)	0.00 (0)	

3.5. Multivariate Analysis of Malaria in Gisagara and Bugesera Districts.

The results from the reduced logistic regression model used the significant variables with malaria in both Gisagara and Bugesera Districts. For Gisagara District, the bivariate analysis of the factors like having radio, having mosquito bed net for sleep, having mobile phone, type of mosquito bed net, person sleeping under treated net, having health insurance, owns livestock herds or farm animals, having bank account were included in reduced model. In Bugesera District, variables such as type of mosquito bed net, person sleeping under the treated net and altitudes were considered for reduced model analysis.

According to the multivariate analysis only not having mosquito bed nets for sleeping with OR= 0.264 CI = [0.118, 0.593], it had an association with malaria in Gisagara District. Therefore, in Gisagara District not having mosquito bed nets for sleeping is 0.264 times less likely of having malaria than those who have mosquito bed nets.

The results of multivariate analysis in Bugesera District show one variable with a significant level .The explanatory variable such low as altitude is 2.768 times more likely to have malaria than those of high altitude.

Table 7. Multivariate Analysis of Malaria in Gisagara and Bugesera Districts.

Gisagara District				Bugesera District		
Results of Malaria tests	**OR**	**CI at 95%**	**Pv**	**OR**	**CI at 95%**	**pv**
Having a radio	1			-		
No	1	-	-	-	-	-
Having mosquito bed nets for sleeping	1			-		
No	0.264	0.118-0.593	0.001***	-	-	-
Having a mobile phone	1			-		
No	1	-	-	-	-	-
Owns livestock	1					
Yes	0.630	0.277-1.431	0.27	-	-	-
Having a bank account	1			-		
Yes	0.697	0.293-1.656	0.414	-	-	-
Using mosquito bed net last night	1			1		
Both treated (itn) and Untreated nets	1	-	-	1		
Person slept under even treated net	1			1		
N0	1			1		
Covered by health insurance	1			-		
No	1	-	-	-	-	-
Altitudes (1401-1500)	-			1		
1301-1400	-	-	-	2.768	1.353-5.662	0.005***
1501-1600	-	-	-	-	-	-
1601-1700	-	-	-	-	-	-
1701-1800	-	-	-	-	-	-

The sign in table means: *** P-value <0.01%, ** P-value <0.05 and * P-value <0.1%. Test differences for vegetable farmers characteristics through independents t-test and chi-square.

3.6. Discussion

This study evaluated the main factors associated with the main cause of malaria and the prevalence of malaria in Gisagara and Bugesera Districts. Utilizing reduced logistic regression model analysis in which only significant explanatory variables are taken into consideration, research questions were tested.

Prevalence of Malaria in Gisagara and Bugesera Districts

According to the 2010 RDHS, malaria prevalence has decreased from 2.6 percent in 2008 to 1.4 percent in 2010 in children under 5 years and a decline from 1.4 percent in 2008 to 0.7 percent in 2010 of malaria prevalence in pregnant women(22). In this study it was proven that among all surveyed households in Gisagara and Bugesera Districts, the prevalence rate of malaria was 10.08% (39/387) and 12.71% (45/354) in Gisagara and Bugesera Districts respectively. The higher rate in Bugesera District comparatively to Gisagara with the rate of 88.89% in male and 11.11% in female in Bugesera District compared to 64.10% in male and 35.90% in female in Gisagara District among all infected by malaria in the study areas. According to the conducted study in Kola Diba, North Gondar, Ethiopia of ten year trend analysis of malaria prevalence, the results showed that the majority of men were infected by malaria, the same as the results of our study. This study proved that infection rates among males were 52.6% and females were 47.3%(23).

Associated factors

The analysis results show that, the majority of households lived on altitudes less than 1400m were much more exposed to malaria disease more than those who were living on elevation greater than 1400m in Bugesera District. The more infected by malaria in Bugesera District were 55.65%, located on elevation less than 1400m while 44.35% people infected by malaria were living on elevation above 1400m.In Gisagara District, majority of the patients infected by malaria, their cluster were on altitudes less than 1600m. The altitude in Gisagara District was not statistically significant, while in Bugesera District, altitude was statistically significant with malaria proven by the P-value of 0.005 which was less than P-value at the statistically significant level of 5% ($P<0.005$). The same results conducted in Uganda, on prevalence and Risk factors of malaria in Uganda, proved that the majority of the sampled households 92.5% were in clusters with altitudes ranging between 1000m and 1500m. A very small portion of the households 7.4% was in clusters with altitudes higher than 1500m, where malaria transmission is lower (24).

According to the results of multivariate analysis, it showed that, visited and interviewed households who had not mosquito bed nets for sleeping were 0.264 times less likely to be infected by malaria if compare with those who had mosquito bed nets for sleeping with OR=0.264, 95% CI=[0.118, 0.593]. The protective factor in Gisagara District may be associated in others factors not listed in this study like prevention using indoor residual spraying (IRS), cutting of bush around the houses, sleeping times, having mosquito bed nets and not used it correctly, having mosquito bed nets and those mosquito do not meet the standards(not treated, having holes around, not cover the all beds), having mosquito bed nets and the households cooks outside the house during night hours, having mosquito bed nets and your environment is covered by stagnant water, bush around the house which is also associated by the Akanyaru river valley and multiple valley located in Gisagara District and households could have more rooms than the available mosquito bed nets.

The policy makers in the ministry of health should increase their effort in taking the proper measures that could allow the prevention and eradicate totally to the malaria attributed deaths in the region of low altitudes. As it was shown in this analysis, the majority of households cluster located on altitudes less than 1400m.

The government of Rwanda may put an effort by using the higher protective medicine used in program of Indoor Residual Spraying (IRS) and improving the sensitization among the families' members to use the LLINs mosquito bed nets. The government of Rwanda put unforgettable and inconsiderable effort in order to assure the well-being of Rwandan people, but the government of Rwanda also may increase their effort in sensitizing the whole people the way they could behave in order to eradicate the malaria in Rwanda through all possible means. The people in general may be sensitized to acquire all information that the government of Rwanda disseminated through the different channel of health communication.

Study limitations

A comparative analysis of risk factors of malaria in both Gisagara and Bugesera Districts of Rwanda was associated with the following limitations:

As the study was a Cross-sectional servey using DHS data, some variables independents variables were missing.

Despite this limitation, furthermore, the objectives of the study were reached.

CHAPTER FOUR: CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

The results of our study showed a prevalence of 10.08% and 12.71% in Gisagara and Bugesera Districts respectively which was high in Bugesera District than in Gisagara District. The results of environmental and geographical status in both Districts such altitude was statistically significant with malaria in Bugesera District and not having mosquito bed nets for sleeping was the protective factor with malaria than those who have mosquito bed nets in Gisagara District.

This means that, not having mosquito bed nets for sleeping is 0.264 times less likely of having malaria than those who have mosquito bed nets in Gisagara District, and households living in low altitude were 2.768 times more likely of having malaria than those households living in high altitude in Bugesera District.

4.2. Recommendations

Based on the results of our research which show high prevalence rate of malaria in Bugesera District than in Gisagara District and based on the associated risk factors such not having mosquito bed nets for sleeping which resulted as a protective predictor in Gisagara District and in household lived in low altitude resulted as an associated factor with malaria than those who lived in high altitude in Bugesera District.

The recommendations are as follow:

- The policymakers, the local leader, stakeholders and the all community to take action, engagement and participation in implementing the policies elaborated for malaria prevention and eradication.
- To strengthen a continuous monitoring and evaluation tools designed to control malaria cases.
- To provide appropriate prevention measures such as mosquito bet net in risk zone areas and to regular check their status.
- To elaborate different policies and implementation strategies by combination of community participation during the process of policy formulation for malaria.
- To promote and sensitize the population the use of the mosquito bet net and the risks associated with the malaria infection.
- Further study of risk factors associated with malaria in each district by using primary data.

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Annex 1: Multivariate analysis of malaria test results with combined data of study areas (Two Districts)

Variable	Odds Ratio	P-Value	[95%CI]	
Marital Status (Never married)	1.00			
Married	0.969326	0.987	0.024084	39.01343
Living together	2.881353	0.6	0.055357	149.9754
Widowed	1.00			
Divorced	1.00			
Not living together	3.702279	0.501	0.081957	167.2445
Having radio (No)	1.00			
Yes	8.513177	0.071	0.831294	87.18235
Covered by Health insurance (No)	1.00			
Yes	0.854899	0.896	0.081386	8.980036
Distance from the house (>200 meters)	1.00			
200-500 meters	2.958428	0.469	0.157174	55.68547
More than 500 meters	2.930267	0.474	0.15404	55.74197
Altitudes (1301-1400)	1.00			
1401-1500	0.349084	0.354	0.03774	3.22895
1501-1500	1.243544	0.853	0.124072	12.46375
1501-1600	1.00			
1601-1700	1.00			
Number of mosquito bed nets (1)	1.00			
2	0.627754	0.657	0.080555	4.89199
3	0.097646	0.2	0.002778	3.432199
4	1.00			
5	26.25139	0.085	0.635818	1083.857
Mosquito bed net designation number (1)	1.00			
2	12.00167	0.212	0.241596	596.203
3	1.00			