KNOWLEDGE, CONTROL PRACTICES, TRANSMISSION RISK FACTORS AND CASES TREND FOR MALARIA AMONG STUDENTS OF SELECTED HIGHER EDUCATION INSTITUTIONS IN EASTERN TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN EPIDEMIOLOGY OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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EXTENDED ABSTRACT

In Tanzania malaria accounts for over 30% of the national disease burden and over 95% of the total population is at risk of getting malaria infection. Higher education institutions (HEIs) do form clusters with different malaria transmission dynamics, but no study conducted in such clusters. This study was conducted to assess Knowledge, control practices, transmission risk factors and cases trend on malaria among students of selected higher education institutions within Morogoro Municipality, eastern Tanzania. A cross sectional and repeated cross sectional survey was conducted in four major Universities; a face to face semi structured questionnaire was administered to 398 undergraduates and supplemented with direct observation. A One Way ANOVA (p .000) at 95% CL demonstrated a prevailing low knowledge level on malaria (58.8%) among respondents. A repeated cross-sectional survey for six months regarding seasonal data (wet and dry season) revealed a total of 181 possible breeding sites. As per study breeding sites; wet season had 11072 and 3620 *Anopheline* and *Culecine* larva respectively; dry season had 1436 and 880 *Anopheline* and *Culecine* larva respectively. Also a ten-year (2011 – 2020) data on malaria cases from catchment health facilities in each institution were analyzed, a binary logistic regression (p. <0.05) at 95% CL shown that; males were positive by 3.3 percent less than females, dry season had 2.6 percent less as compared to wet season. Jordan had positive malaria cases by 2.3 times more and Mzumbe by 17.8% less as compared to SUA. The total positive cases were 65969 (34.1%) out of 193243. This study has indicated the prevailing low knowledge level and control practices on malaria among respondents with high exposure and transmission risk. This may impede the efforts towards malaria control and elimination. Therefore, there is an urgent need for control strategies that are most appropriate to higher education institutions and similar clusters.

DECLARATION

I, MBOGO NG'WISABILA KIJA, do hereby declare to the Senate of Sokoine University of Agriculture that, this thesis is my own original work and that it has neither been submitted nor concurrently submitted for a degree award in any other institution.

_____ _____

Mbogo Ng'wisabila Kija. Date

(MSc. Candidate)

The above declaration is confirmed;

_____ _____

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DEDICATION

This work is dedicated to my beloved wife Lyidia Pantaleo and my daughter Buholo Mbogo for their moral support, encouragement and tolerance during my absence from home. Secondly, this dissertation is also dedicated to my beloved parents Mr. Ng’wisabila Kija and Sara Kija

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LIST OF ABBREVIATIONS AND SYMBOLS

AIDS	Acquired Immunodeficiency Syndrome
CL	Confidence Level
EC	Electrical Conductivity
GDP	Gross Domestic Product
GPS	Geographical Positioning System
HIV	Human Immunodeficiency Virus
JUCO	Jordan University College
HEIs	Higher education institutions
IRS	Indoor residual spraying
Lab	Laboratory
LLINs	Long-lasting insecticidal nets
m	Meter
mRDT	Malaria Rapid Diagnostic Test
MU	Mzumbe University
MUM	Muslim University College of Morogoro
n	Number
P	Level of significance
RI	Residual insecticides
SSA	Sub-Saharan Africa
SUA	Sokoine University of Agriculture
TDS	Total Dissolved Solids
WHO	World Health Organization
USD	United States Dollar

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 The burden of malaria

Malaria is a preventable acute febrile illness caused by plasmodium parasites which are spread to human through the bites of infected female *Anopheles* mosquitoes, and it presents with the symptoms of fever, chills, headache, loss of appetite, nausea/vomiting and fatigue that usually appear within 10 to 15 days after infective mosquito bite (WHO, 2020). The burden of malaria has decreased by nearly a half within the past decade across many endemic regions particularly sub-Saharan Africa. This decrease has been contributed by the massive scale-up of frontline mosquito vector control tools including;- long lasting insecticidal nets (LLINs), indoor residual spraying (IRS), as well as improved diagnosis and treatment (WHO, 2019).

Despite the recorded reduction, malaria still remains one of the major public health problem worldwide causing more than 229 million cases and 409, 000 deaths annually (WHO, 2020). More than 95% of the recorded cases and deaths occur in sub-Saharan Africa (SSA), more so in the under-five children and pregnant women (WHO, 2020). In 2019, the under-five children accounted for 67% (274 000) of all malaria deaths worldwide (WHO, 2020). Furthermore, malaria is an important cause of stillbirths, low birth weight, and early infant mortalities (Ibrahim *et al.,* 2016).The disease causes repeated absenteeism from work resulting in short- and long -term losses in socio-economic productivity and scholastic performance (Ibrahim *et al.,* 2016; Msugupakulya *et al.,* 2020).

Moreover, malaria exerts great economic burden, which is largely associated with personal and public expenditures on both prevention and treatment of the disease (WHO, 2019). At the micro level, the personal expenditures include individual or family spending on long lasting insecticidal nets (LLINs), other control interventions, antimalarials, transport to health facilities, and support for the patient during hospital stays (Alonso *et al.,* 2019). At the macro level, the burdens estimated at an average annual reduction in economic growth of 1.3% for those African countries experiencing the highest malaria burden with an estimated 12 billion USD loss to African continent's GDP (Karunamoorthi, 2012; Elnour *et al*., 2019).

Tanzania is one of the top ten countries with high malaria transmission and population at risk in eastern and southern African regions (Rumisha *et al.,* 2018). The country accounts for 5% of the global malaria burden and over 95% of the population is at risk of infection (MoHSW, 2014; USAID, 2019). Malaria contributes to 26% of all outpatient attendances in the country resulting to approximately 7.7 million confirmed and clinical cases annually (WHO, 2011; TDHS-MIS, 2016).

1.2 Malaria parasites and vectors

From approximately 100 parasite species of the genus *Plasmodium*, only five have been implicated in causing malaria in human including *P. falciparum*, *P. malariae*, *P. ovale*, *P. vivax* and *P. knowlesi* (WHO, 2018). Of these, *P. falciparum* is the deadliest and most widely distributed parasite and is responsible for about 98% of all malaria cases in the African region (Ibrahim *et al.*, 2016; de Souza *et al*., 2016). *Plasmodium knowlesi*, originally known to cause simian malaria, is now recognized as the fifth human malarial parasite and has been reported in nearly all the countries in Southeast Asia and in travelers returning from these countries (Amir *et al.,* 2018). The parasite's natural

reservoir hosts are the long-tailed macaque, pig-tailed macaque, and the banded-leaf monkey (Amir *et al.,* 2018).

Malaria parasites are transmitted through the bites of female mosquitoes of the genus *Anopheles*. Worldwide, there are more than 400 anopheline mosquitoes out of which about 30 are involved in malaria transmission (Geoffrey *et al.,* 2017). In SSA, less than 20 of the 140 described anopheline species have been confirmed to transmit malaria (Gillies *et al.,* 1968). The major vector species include *An. arabiensis, An. gambiae* s.s., and *An. funestus* s.s. (Okwa *et al.,* 2007; Dida *et al.,* 2018). Originally, *An. gambiae* s.s constituted the vast majority of malaria vectors in SSA, however, in the last ten years, these species have been surpassed by *An. arabiensis* and *An. funestus* s.s (Geoffrey *et al.,* 2017). Climate, local ecology and active control affect the ability of malaria parasites and their anopheline mosquito vectors to coexist long enough to enable transmission (Aikambe and Mnyone, 2020).

1.2.1 Malaria transmission risk factors

Variation in environmental and socio demographic factors may affect the pathophysiology of malaria transmission (Stresman, 2010; Ardiet *et al.,* 2014). The most important environmental factors include among others the topography, temperature, rainfall, humidity, vegetation cover and water bodies. The socio demographic factors which may be attributed to malaria transmission risk include age, sex, literate rate, socio economic activities, income level, nutritional status, behaviour and cultural practices (Kar *et al.,* 2014; Chirebvu *et al.,* 2016).

Living in houses that are easily accessed by mosquitoes through openings in windows, doors, roofs, vents and close to uncontrolled water bodies all increase malaria transmission risk (Rand *et al.,* 2013). Likewise, premises that are not sprayed or no any indoor and outdoor mosquito control measures employed have relatively high possibility of malaria transmission (Naing *et al.,* 2017). Furthermore, human attitudes and perceptions towards malaria control measures, and amount of time spent outdoors during the night are increasingly attributed to increased malaria transmission (Adinan *et al.,* 2017; Moshi *et al*., 2018).

1.2.2 Control and treatment seeking behaviours towards malaria

Interventions that target malaria mosquito vectors remain the mainstay of malaria control worldwide. Overall, this approach aims to reduce human-vector contact and protect individuals from infection as well as reducing transmission at the community level. This can be achieved by deploying different measures including larval source management (Challet, 1994; Dale *et al.,* 2008), LLINs and IRS (Bhatt *et al.,* 2015; WHO, 2020), house improvements (Killeen *et al.,* 2017) and repellents of all types (Deressa *et al.,* 2014). Of these, LLINs and IRS are the most powerful and extensively deployed measures in endemic areas (Killeen *et al.,* 2016; WHO, 2020). Massive use of LLINs and IRS has contributed to significant reduction of malaria transmission and burden worldwide particularly in SSA (Bhatt *et al.,* 2015; WHO, 2019). In fact, the combined use of these vector control measures as well as improved disease diagnosis and treatment have halved malaria cases and deaths in SSA and other disease endemic areas (USAID, 2019).

The other types of vector control measures like larval source management and use of repellents have not yet gained large-scale application because are relatively more costly

and logistically challenging. However, the increasing problem of insecticide resistance against LLINs and IRS has prompted increased attention to other existing and new control measures (Kessy *et al.,* 2020; Msugupakulya *et al*., 2020). Studies have reported insecticide resistance to major malaria vector species against virtually to all four classes of chemical insecticides (Muangphrom *et al*., 2016; Awolola *et al.,* 2018). The integration of LLINs and IRS with other control interventions will assist in managing the problem of insecticide resistance whilst increasing the effective lifespan of LLINs and IRS.

Case management, prompt diagnosis and treatment with artemisinin-based combination therapies (ACTs) are other equally important interventions against malaria. The emphasis on early treatment seeking by the general community is of paramount towards early diagnosis and case management (Chipwaza *et al*., 2014; Telemu *et al*., 2016; Adinan *et al*., 2017). The level of treatment seeking behaviour is still a challenge in many communities as a good number of people still go for self-medication and traditional healers (Mazigo *et al*., 2010; Chipwaza *et al*., 2014). The treatment seeking behaviour and adherence to malaria treatment are dictated by socio-demographic factors such as age, gender, income, education, culture and the environmental settings (Kigodi, 2006; Cassy *et al.,* 2019).

1.3 Characterization and distribution of mosquito habitats

Mosquito reproduction is highly dependent on the availability of water bodies, vegetation, their sizes, proximity to human habitation, water colour and state (moving or static), exposure to direct sunlight among others (Xiao-Bo Liu *et al*., 2012; Mattah *et al*., 2015). Physico-chemical parameters such as water temperature, water pH, electrical conductivity of water and total dissolved solids are among other factors which also influence the spatial distribution of malaria and other mosquito vector species (Dida *et al*., 2018).

These parameters may have a positive or negative influence on mosquito reproduction depending on their relative levels causing a variation in spatial distribution of mosquito vector species across the wet and dry seasons (Emidi *et al*., 2017; Zogo *et al*., 2019).

1.3.1 Malaria data documentation, storage and availability

Obtaining an up to date and past information on malaria is a challenge to many countries across the globe, as such there is a need for every country to have functional health surveillance systems that will ensure availability of updated information for both the disease and mosquito vectors (Mueller *et al.,* 2011; Russell *et al., 2020).* An effective malaria surveillance system will ensure timely and good quality data (WHO, 2012; Lourenço *et al.,* 2019). Indeed, strong and responsive surveillance systems are inevitable component of the efforts towards malaria elimination (Ohrt *et al.,* 2015). Malaria endemic countries, which also experience the greatest disease burden, should be strict in recording and keeping track on malaria data as the data serves as an important tool in gauging the disease progress from time to time (Greenwood *et al.,* 2012; Greenwood *et al*., 2018). In Tanzania, there are several advancements in the health system but data on malaria is still a challenge especially in some clusters such as school aged persons and data from the past years are not easily available in an electronic form (Zablon *et al.,* 2015; Chacky *et al*., 2018).

1.4 Problem statement and study justification

Although malaria incidence and mortality has significantly declined in Tanzania, the disease still accounts for over 30% of the national disease burden, making it the top health priority for allocation of resources for its surveillance and control (Mboera *et al.,* 2007). Despite the overall decline in malaria burden, clusters characterized by unusually high number of malaria cases than expected still exist in Tanzania as the occurrence of the

disease exhibit fine-scale heterogeneity (Aikambe and Mnyone, 2020). Accurate characterization of area-specific situations in terms of knowledge, control practices, transmission risk factors, mosquito breeding sites and malaria cases trend is of paramount. Despite this assertion no study has been conducted in such clusters in Tanzania. This study therefore aimed to assess malaria control practices, treatment seeking behaviour, transmission risk factors and malaria cases trend among students of four higher education institutions within Morogoro Municipality, eastern Tanzania.

4.5 Significance of the study

A clear understanding of the area-specific knowledge, control practices, treatment seeking behaviour, malaria transmission risk factors and malaria cases trend will help in designing malaria awareness campaigns and control strategies that are most appropriate to higher education institutions and similar clusters.

1.6 Study objectives

1.6.1 General objective

To understand the malaria control practices, treatment seeking behaviour, transmission risk factors and cases trend among students of selected higher education institutions in view of designing appropriate awareness campaigns and disease control strategies.

1.6.2 Specific objectives

i. To assess the knowledge, control practices and treatment seeking behaviour on malaria among students of selected higher education institutions in Morogoro municipality

ii. To determine environmental and human factors contributing to malaria transmission risk among students in selected institutions

iii. To assess the characteristics, distribution and larval abundance of mosquito breeding sites in selected institutions

iv. To conduct a retrospective analysis of malaria cases data registered in selected institutions over the last ten years.

1.7 Research questions

i. Does the level of malaria related knowledge, control practices and treatment seeking behaviour differ across the selected institutions?

ii. Do the environmental and human factors contributing to malaria transmission risk differ across the selected institutions?

iii. How does the characteristics and larval abundance of malaria mosquito breeding sites differ across the selected institutions?

iv. Does the trend of malaria cases differ across the selected institutions over the last ten years?

CHAPTER TWO

Paper One

2.0 Knowledge, Control Practices and Treatment Seeking Behaviour Regarding Malaria Among Students of Higher Education Institutions (HEIs) in Morogoro Urban District, Eastern Tanzania

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Paper Two

3.0 Characterization of Breeding Habitats and Larval Abundance of Malaria Vectors across Selected Higher Education Institutions (HEls), in Morogoro Region, Tanzania

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Paper Three

4.0 Retrospective Analysis of Malaria Cases in Selected Higher Education Institutions in Morogoro Municipality, Eastern Tanzania

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CHAPTER THREE

5.0 GENERAL DISCUSSION

The overall result of this study has found a prevailing low level of knowledge on malaria among study respondents (58.8%) whereby females shown to have high knowledge by 46.5 percent as compared to 35.9 percent for males. The low level of knowledge on the disease increases the risk for transmission hence making them prone to the infection. Since malaria is preventable, a clear understanding of the disease together with implementation of control practices is expected to yield positive outcome towards prevention and elimination of the disease. However, knowledge alone without intentional strategies for deploying control practices especially to the study clusters is not enough to bring positive outcome as revealed from SUA respondents that about 56.3% have good knowledge of the disease whereas only 34.1% sleep under bed nets. This corresponds to the study by Kigodi (2006) in the rural community of Tanzania that revealed 36.8% of the study subjects were knowledgeable, for which women had more knowledge than males (38.8% and 33.7% respectively. Also, respondents need to be aware that they may get malaria infection at early morning and late evening mosquito bites and not only at mid and late night (2100 pm - 0500 am) as reported by the majority. This corresponds with the study done in Southeastern Tanzania by Finda *et al*. (2019) for which all respondents believed the critical time at which a person can easily be infected with malaria was between midnight and 0200 am (‘usiku wa manane’ a Swahili slogan). Likewise, Mathania *et al*. (2016) in their study carried in Morogoro and Dodoma regions of Tanzania reported a 78.8 % of respondents were unaware if early mosquito bites can cause malaria.

Less than half of respondents understand correctly on how malaria is transmitted to human and about quarter of respondents understand correctly three diseases that present with fever. This means, majority of respondents were unaware of the route of the disease transmission and how it relates with other febrile illnesses for which only 24% of all study respondents understand correctly about other three diseases presenting with fever and only 32% were able to correctly mention the five typical signs and symptoms of malaria in human. The low understanding on the disease is not good for these clusters as are regarded as a group of educated people and leaders of tomorrow who soon join the community after studies and the community is eager to learn from them. This relates to a study by Chipwaza *et al*. (2014) conducted in Eastern Tanzania and revealed low knowledge level among respondents on non-malaria illnesses presenting with fever. About 31.9% of respondents understand correctly the typical symptoms of malaria in human. It also resembles to a study by Adetola (2014) in Nigeria that reported a 26.4% of respondents who were knowledgeable on the common symptoms of malaria and upon mentioning severe symptoms the knowledge level declined drastically to 13.1%, 13.5% and 7.9% for convulsion, coma and anaemia respectively.

About 42% of all study respondents reported to use mosquito nets. It means less than half of respondents do not sleep under mosquito nets and about 23% dislike them, Not able to buy (20.6%), Suffocation or health problems (14.6%) and Dislike (22.8%). It is therefore important to make intentional efforts to make sure that respondents use mosquito nets as they still the most effective way of preventing the disease, this should be done by incorporating all the above reasons and special arrangements to be done for the allergic persons. Chinweuba *et al.* (2017) in their study found 40.5 % of respondents in South-East Nigeria slept under mosquito nets (both treated and untreated) and 22.1% reported by Adetola (2014), 18% in Kavango East, Namibia (Jacob and Nuuyoma, 2019) and

44.7% for bed nets use and 4.5% for body spray or ointment on daily bases while the rest infrequently use ointment or spray or do not bother at all (Nyahoga and Bochkaeva, 2018). This is contrary to a study by Chacky *et al*. (2018) conducted in Mainland Tanzania that reported 70% of primary schools children used mosquito nets. This difference might be due to the fact that pupils are under close parental care and they normally obey their parents' order. Nevertheless, children seem to be keen when are informed of a possible danger as compared to young adults who are more likely to neglect on some matters.

The overall use of Personal mosquito repellents before bedding among study respondents was 7.8 percent, the use of insecticides or mosquito repellents in a sleeping room was 27.1% and the type of clothes worn by students during night before going to sleep was 38.7% and 61.3% for long and short clothes. This indicates that majority of respondents are at high risk of getting malaria infection as they are in close contact with mosquito bites especially during night time study and social affairs that keeps them out of bed.

About 30.7% of respondents visit health care facilities after noticing of having fever while the rest 69.3% of respondents opt for self-remedies such as praying, sleep, drink much fluids especially water, eat fruits and leaves, exercise and taking anti pains/antipyretics. This implies that majority of respondents do not bother about early visiting to health facilities a situation that makes be reservoirs for the disease as well as giving chance for the disease to get complicated and possible drug resistance. About 91.5% used antimalarial medicines after being diagnosed of having malaria for which ALU/MSETO was the most used drug (66.3%) among others and the majority seemed to complete their full courses of the doses. This is similar to the study by Mazigo *et al*. (2010) done in Rural Northwest Tanzania and in Kilosa District-Morogoro

(Chipwaza *et al.,* 2014). However, males are more likely to use antimalarial medicines without medical advice as compared to females (52.2% and 38% respectively) (Kigodi *et al.,* 2006). Also a study in Mozambique had shown a low level on treatment seeking habit (Cassy *et al.,* 2019) and in the study done in South-East Nigeria revealed a 63.0% of respondents purchased any antimalarial medicine available at a shop and 85.2% of the women would complete their prescribed dose (Chinweuba *et al.,* 2017).

Generally, study respondents do not practice early medical care until the condition is complicated. This resembles to a study found that people go to buy drugs from the nearby shops or stores when sick and tend to go to the hospital when condition is unbearable as revealed in Nigeria (Okechukwu *et al.,* 2016).

The most favourable places for self-studies in order of magnitude were as follows; Classes (33.7%), Room (31.9%), Hostel (19.8%), Library (12.6%) and Hall (2.0%). About 75.4% of respondents seemed to live in sleeping rooms having windows fixed with mosquito proof wire mesh, 67.1% sleep in doors and roofs fixed properly not to allow mosquito entry and 18.6% of respondents understand correctly the common risk factors for Malaria transmission in human. Improvement of the school premises is of great importance as these are the places occupied by the students whom we want to protect them from malaria infect infection. In general, living or studying in houses that are not sprayed or no any indoor mosquito control measures employed, together with low understanding on transmission risk factors increases the risk for malaria infection (Rand *et al.,* 2013; Naing *et al.,* 2017).

Also, majority of respondents (90.7%) shown to bed after 2100 pm and waking at night for prayers, wash room services or other activities out of bed at; One time (47.0%),

Two times (22.6%), Three times (6.8%) and Four times (3.0%). With this fact it adds to the increased possibility of mosquito bites to respondents hence malaria infection. This corresponds with a study done in South-Eastern Tanzania on outdoor malaria transmission risks and social life that noted to increase risk with increasing time spent outdoors mostly at night (Moshi et *al.,* 2018). About 80.4% of respondents used to store water in buckets within their sleeping rooms for which 43.7% of respondents leave their buckets unclosed. This correlates with the study done in South-East Nigeria for which 33.1% of respondents kept water in their sleeping rooms with their containers closed (Chinweuba *et al.,* 2017).

Up on characterization of surrounding mosquito breeding sites; during wet season, a Pearson correlation results revealed the following; Size of the breeding site had a negative correlation (-0.095) at p value .035 implying that the smaller the breeding site, the greater number of mosquito larva was found. This concurs with a study in Gambia, China and Ethiopia that observed mosquito larval density to be significantly associated with habitats that had smaller perimeters (Fillinger *et al.,* 2009; Xiao-Bo Liu *et al.,* 2012; Getachew *et al.,* 2020). Similarly, a study in Dar es Salaam, Tanzania and Southwest Ethiopia revealed a high number of *Anopheles* larva to be found in breeding sites with small diameters (Sattler *et al.,* 2005; Mereta *et al*., 2013).

Water temperature had a positive correlation (0.296) at p value .000 implying that the breeding sites in which water temperature was high then greater number of mosquito larva was found. This agrees with the study in Kenya and Tanzania on spatial distribution and habitat characterization of mosquito species (Dida *et al*., 2018; Fagbohun *et al.,* 2020). Unlikely a study in Ethiopia shown water temperature was not significantly associated with larval abundance (Getachew *et al*., 2020). This difference could be

accounted in a sense that usually the climate of Ethiopia is sunny and dry hence little or no effect to mosquito reproduction. EC had a positive correlation (0.135) at p value .005 and TDS (0.108) at p value 0.026. It reflects the fact that in breeding sites whose water had high level of EC and TDS many mosquito larva were found. This is similarly to a study in Dakar and Muheza, Tanzania shown these parameters to be positively correlated with larval density (Machault *et al*., 2009; Emidi *et al*., 2017).

A Mann Whitney test results shown that there was no statistical significant difference among the variables since the p value for water colour was 0.317 and for nature was 0.378 except for state of water. This is because most of the breeding sites were artificial and the stagnant state of water found to contain many larva as there is no washout effect for settled water. Likewise, a study done in the Cape Verde islands revealed that mosquito's reproduction was dependent of non-moving water shaped by human activities (Mattah *et al*., 2017).

A Kruskal Wallis test had the following results; presence of shade had a p value of .056 implying that there was a significant difference in mosquito larval abundance in relation to amount of shade at the breeding site and vegetation quantity had a p value of .036, implying that there was a significant difference in mosquito larval abundance in relation to amount of vegetation at the breeding site and the rest did not show a statistical significant difference. It means, the shade and surrounding vegetation impairs mosquito reproduction since mosquito prefers to breed in water surfaces that are open and have access to direct sunlight. Similarly, a study in Gambia, Tanzania and Ethiopia shown that larval abundance was associated with breeding sites those were sunlit, fewer vegetation cover and absence of emergent plants and it was not associated with water pH, water

turbidity, amount of algae, and water depth (Fillinger *et al*., 2009; Castro *et al*., 2010; Dejenie *et al*., 2011; Getachew *et al*., 2020.

For dry season, the correlational results revealed that there was no statistical significant difference in larval abundance in relation to the size of the breeding site, water temperature, EC and TDS as similarly to a study in Ethiopia (Getachew *et al*., 2020). This is due to the fact that during dry season there is little or no dilution effect on water and only little changes occurred in most of the breeding sites surroundings.

Mann Whitney test, results showed a statistical significant difference for nature of the breeding site with a p value of .000 while there was no statistical significant difference for larval abundance in relation to water colour (p. 0.490). Meaning that after rain season some of the breeding sites were reshaped to natural due to rain action and water colour had no effect anymore because mosquitoes have to adapt the harsh environment and be forced to breed where there is water regardless of the colour. A Kruskal Wallis test had the following results; presence of shade, habitat type, type of adjacent vegetation, vegetation quantity, presence of algae and distance to the nearest building all had a p value of p .000, implying that there was a significant difference in mosquito larval abundance in relation to the variations of different features in each particular variable. This concurs with a study in central western Senegal on mapping the mosquito breeding sites that shown larval abundance to gradually decreased with increasing distance (Ndiaye *et al.,* 2020). This reflects the life style of mosquito that is highly dependent on human being for blood meal especially during reproduction in female adult mosquitoes.

Generally, with regard to the study breeding sites; wet season seemed to have many breeding habitats with high larval densities as compared to dry season. This is because in

wet season all the necessary conditions for mosquitos' reproduction are available and they have a wide range of choice as compared to dry season. This resembles a study in Ghana, Northern Côte d'Ivoire and Senegal (Mattah *et al*., 2017; Zogo *et al*., 2019; Ndiaye *et al.,* 2020). This also reflects as to why most of the breeding site features during dry season were statistically significant as there were no frequent changes for the surrounding vegetation due to drying effect resulting to little or no water to support life.

Upon retrospective analysis of malaria cases data (2011 – 2020), the test results showed a statistical significant difference among the variables of interest (malaria test result, Age group, Sex, place/location and Seasonality). It demonstrated that females were more affected by malaria by 3.3 percent as compared to males, that is 33 415 (50.7%) out of 65 969 and many positive malaria cases were observed in patients aged 5 and above 5 years by 11.2% more than patients aged below 5 years (in five and above years old were 59 679 (90.5%)). This concurs with the findings of the study on malaria transmission trends in Botswana by Chirebvu *et al*. (2016). In line with this, Aikambe and Mnyone (2020) in their study at Mkuyuni and Kiroka of Morogoro region revealed the same except for the age group. The difference in age group is due to the fact that malaria cases data were from the health facilities within the Universities for which the majority of patients were students/adults.

With respect to seasons, wet season had many positive malaria cases by 2.6 percent more as compared to dry season (wet season 34 493(52.3%) and Dry season 31 476 (47.7%) as in Appendix 4. It means the wet season recorded the higher number of malaria cases as compared to dry season where the number of cases decreased as the result of seasonal effect that deters mosquito reproduction. This corresponds with the retrospective study in Mpwapwa District of Morogoro for which malaria positive cases had a positive

correlation with rainfall (Mboera *et al.,* 2005) and also in a study done in Kagera region (Jones *et al.,* 2007). With respect to location; SUA had many positive malaria cases by 41.4% (27 320) followed by Mzumbe 35.9% (23 690) and Jordan 22.7% (14 959). The variation in malaria transmission is related to the varied environmental risk factors such as vegetation cover, land use, temperature, precipitation and local elevation (Bousema *et al.,* 2011; Landier *et al.,* 2018).

The overall trend of malaria positive cases has shown to decrease from time to time starting from 2017 onwards as revealed from all three Institutions. This could be due to the introduction and wide use of rapid malaria diagnostic test (mRDT) together with the positive outcomes of several interventions made by the Government and other stake holders. This is similar to the report by the United States Agency for International Development (USAID, 2020).

However, this study revealed a malaria prevalence rate of 34.1% that relates with the recent study in Morogoro, Tanzania by Aikambe and Mnyone (2020) that observed a prevalence rate of 60.98%. This prevalence is higher than the 9.5% nationwide reported in 2017 by the Tanzania Ministry of Health (MoHCDGEC, 2017) hence calling attention for further studies since most of the regions in the country are endemic to the disease.

CHAPTER FOUR

6.0 GENERAL CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

This study has revealed a prevailing low knowledge level on malaria among University students in the study area. It was observed that about 58.8% of all respondents in the study institutions were less knowledgeable on malaria. This situation makes majority of students not abide to the present malaria control practices such as use of insecticides treated nets, repellents of all types, sprays and early medical care seeking upon feeling of fever.

The University buildings are not sprayed with residual insecticides targeting mosquitoes rather an annual fumigation is done for other insects like bed bugs, flies, cockroaches etc. Again, the seasonal data (wet and dry) have shown that the study institutions were highly surrounded by multiple uncontrolled positive mosquito breeding sites for which SUA was leading followed by MUM, MU and JUCO whereby wet season had 11072 and 3620 *Anopheline* and *Culecine* larva respectively; dry season had 1436 and 880 *Anopheline* and *Culecine* larva respectively.

Up on retrospective analysis of a decade (2011 – 2020) on malaria data recorded by the catchment health facilities in three institutions (MUM was taken out since it has no such data) revealed that; males were likely to have positive malaria test results by 3.3 percent less than females; dry season had 2.6 percent less than wet season. Jordan had positive malaria cases by 2.3 times more and Mzumbe by 17.8% less as compared to SUA. In all the three institutions, the total recorded malaria cases data revealed a prevalence of 34.1% which is higher as compared to the efforts put by the government and other stake holders towards malaria control and elimination whilst this group is of people whom we assume are educated. The aforementioned situations in all the HEIs pose a greater risk of

exposure for malaria transmission among University students and similar clusters hence hindering the efforts towards malaria control and elimination both at the national and global level.

6.2 Recommendations

From the study findings, we would recommend that higher education institutions should design imperative awareness campaigns and control strategies that are most appropriate to students and should be updated on a regular basis, to mention a few;

i) Initiation of a special course on malaria that should be integrated in the usual curriculum and be mandatory to every student or be imbedded as one of the essential topic in general studies.

ii) Offer special packages to students on malaria control measures upon registration. The package should include a treated mosquito net and mosquito repellents (creams, coils/mats or spray) that should be offered at the same time when a student is given a living room, bed and mattress. It may be accompanied with initiation of motivational competition on malaria knowledge, prevention and control practices with special awards to those who perform better.

iii) The government should allocate special funds and or formulating suitable policies that will help to reduce the risk of malaria transmission among University students.

iv) Institutions should think of spraying their buildings with RI and insecticides that will target elimination of adult mosquitoes.

v) Targeting the immature stage of mosquito (larva) through controlling of the surrounding mosquito breeding sites with appropriate means. For example the use of bio-larvicides.

vi) Consumption of health data is encouraged at the institutional level in order to gauge student’s health status from time to time preferably on annual bases.

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APPENDICES

Appendix 1: Knowledge Level on Malaria with respect to gender, campus and institution

Institution-ID	Knowledge level			Campus: In campus	Campus: Off campus	Total
JORDAN	Low knowledge on Malaria	Gender	1	7	6	13
			2	3	6	9
		Total		10	12	22
	High knowledge on Malaria	Gender	1	1	2	3
			2	5	2	7
		Total		6	4	10
	Total	Gender	1	8	8	16
			2	8	8	16
		Total		16	16	32
MUSLIM	Low knowledge on Malaria	Gender	1	12	8	20
			2	9	7	16
		Total		21	15	36
	High knowledge on Malaria	Gender	1	2	6	8
			2	5	8	13
		Total		7	14	21
	Total	Gender	1	14	14	28
			2	14	15	29
		Total		28	29	57
MZUMBE	Low knowledge on Malaria	Gender	1	28	25	53
			2	26	24	50
		Total		54	49	103
	High knowledge on Malaria	Gender	1	7	10	17
			2	10	12	22
		Total		17	22	39
	Total	Gender	1	35	35	70
			2	36	36	72
		Total		71	71	142
SUA	Low knowledge on Malaria	Gender	1	21	20	41
			2	21	11	32
		Total		42	31	73
	High knowledge on Malaria	Gender	1	20	23	43
			2	19	32	51
		Total		39	55	94
	Total	Gender	1	41	43	84
			2	40	43	83
		Total		81	86	167
Total	Low knowledge on Malaria	Gender	1	68	59	127
			2	59	48	107
		Total		127 (54.3)	107 (45.7)	234
	High knowledge on Malaria	Gender	1	30	41	71
			2	39	54	93
		Total		69 (42.1)	95 (57.9)	164
	Total	Gender	1	98	100	198
			2	98	102	200

Appendix 2: Questionnaire

Respondent's Questionnaire

Introduction

Dear Respondent, this is part of the research that is aiming at obtaining relevant information regarding "Knowledge, Control Practices and Transmission Risk Factors on Malaria Among Students of Selected High Learning Institutions in Eastern Tanzania" (SUA, Mzumbe, Muslim and Jordan). This interview shall take not more than 20 minutes. You are assured of maximum confidentiality that any information you provide here shall only be used for this research and no any piece of personal information shall be disclosed publicly, so you are encouraged to feel free and provide the most correct answers at your level best. THANKS!

Part 1: ***Identification***

QUESTIONNAIRE NO/ID: _____

DATE OF INTERVIEW: _____

INTERVIEWER NAME: _____

PART II: ***RESPONDENT'S PARTICULARS***

COURSE UNDERTAKEN: 1. _____

YEAR OF STUDY: 2. _____ SEMESTER 3. _____

AGE: 4. _____ GENDER: FEMALE 5. _____ MALE 6. _____

NATIONALITY: 7. _____

PERMANENT RESIDENCE: 8. _____

NAME OF UNIVERSITY: 9. _____

CAMPUS: (*Please check one* √), IN CAMPUS _____ OFFCAMPUS _____

Part III: *Questions*

1. Do you know what is Malaria? (*Please check one* √),

   Yes ☐ No ☐

2. What was the last time of getting it?

(*Please mention*)….....

3. How did you know if it was malaria?

(*Please mention*)….....

4. Did you have any test? (*Please check one* √), Yes ☐ No ☐

5. What type of test did you have?, Microscopy ☐ Rapid test ☐

6. Who ordered the test? (*Please mention*)….....

7. Did you use any Antimalarial medicine for treatment? (*Please check one* √)

   Yes ☐ No ☐

8. Which medicine did you use? (*Please check one* √)

   ALU/Mseto ☐ Fansider/SP ☐ Metakelfin ☐

   Artequick ☐ Quinine ☐ Duocortexin ☐

   Tradidional ☐ Others ☐

   If the answer is others, please mention….....

9. Did you manage to complete the full course of the dose? (*Please check one* √

   Yes ☐ No ☐

10. What was the reason/reasons, (*Please mention*)

    ….....

11. Do you have self-studies at night? (*Please check one* √),

    Yes ☐ No ☐

12. Where is your most favourable place for self-studies? (Please *check one* √)

    Classes ☐ Library ☐ Halls ☐ Hostel ☐ Room ☐

13. At what time do you normally start?, *Please mention* (in 12hr format)….....

14. At what time do you normally end? *Please mention* (in 12hr format)….....

15. At what time do you normally go to bed? *Please mention* (in 12hr format)…...

16. Do you use any mosquito repellent during your study time or before going to bed? (*Please check one* √), Yes ☐ No ☐

17. What type of mosquito repellent do you use? (*Please mention*)

….....

18. How many times do you use per day? (*Please mention*)….....

19. What type of clothes do you normally put on (at night/during your self-study) before going to bed? (*Please mention*)….....

20. Do you sleep under Mosquito net? (*Please check one* √),

Yes ☐ No ☐

21. Is the net you are using treated with insecticides? (*Please check one* √)

Yes ☐ No ☐ I don't know ☐

22. With reference to question 20 and or 21 above, what is the reason(s)? (Please mention).....

23. Do you use insecticides or repellents in your sleeping rooms? (*Please check one* √)

Yes ☐ No ☐

24. What type is it? (*Please mention*)….....

25. How often do you use it? (*Please mention*)….....

26. Are the sleeping rooms having windows fixed with mosquito proof wire mesh? (*Please check one* √) Yes ☐ No ☐

27. Are the sleeping rooms having doors and roofs fixed properly not to allow mosquito entry when closed? (*Please check one* √**)** Yes ☐ No ☐

28. What are the possible ways can a mosquito gain entry into any sleeping room? (*Pleasemention)*

1….....2….....3….....

29. Do you store water in buckets in your sleeping rooms for emergency purposes? (*Please check one* √**)** Yes ☐ No ☐

30. Are the buckets normally open for easy taking the water? Yes ☐ No ☐

31. How many times do you normally wake up at night for washroom or other services out of the bed? (*Please mention*)….....

32. How many people occupy one room? (*Please mention*)….....

33. Have you ever had a fever (feeling of having a high body temperature)? (*Please check one* √) Yes ☐ No ☐

34. Can you give three important guess of what disease was/is it? (*Please mention*)

i) ….....ii)….....iii)….....

35. What do you normally do after noticing that you have fever? (*Please explain in short*….....36.

What does Malaria mean from your own understanding? (*Please explain in short*)

….....

37. How is it transmitted to human? (*Please mention)*

….....

38. What are the possible common living sites for the organism/causative agent of Malaria? (*Please mention)*

1….....2….....3….....4….....

39. At what times of the day do you think you can easily be infected with Malaria? (*Please mention all what you know specifying the time in 12 hour format).*….....

40. What are the typical symptoms of Malaria in human being? (*Please mention*)

    i)….....ii)….....iii)….....

    iv)….....v)….....

41. What do you think are the possible factors that may facilitate a person to be infected with Malaria? (*Please mention*)

    i)….....

    ii)….....

    iii)……

    iv)……

    v)…….

THANK YOU VERY MUCH FOR YOUR MAXIMUM COOPERATION!

Appendix 3: Sex of patient, Malaria test result and Place Malaria tested

Place Malaria test done				Malaria test result Positive	Negative	Total
Jordan Hospital	Sex of patient	Male	Count	8226	7231	15457
			% within Sex of patient	53.2	46.8	100.0
		Female	Count	6733	6005	12738
			% within Sex of patient	52.9	47.1	100.0
	Total		Count	14959	13236	28195
			% within Sex of patient	53.1	46.9	100.0
Mzumbe Hospital	Sex of patient	Male	Count	11064	26830	37894
			% within Sex of patient	29.2	70.8	100.0
		Female	Count	12626	31830	44456
			% within Sex of patient	28.4	71.6	100.0
	Total		Count	23690	58660	82350
			% within Sex of patient	28.8	71.2	100.0
SUA Hospital	Sex of patient	Male	Count	13264	26422	39686
			% within Sex of patient	33.4	66.6	100.0
		Female	Count	14056	28956	43012
			% within Sex of patient	32.7	67.3	100.0
	Total		Count	27320	55378	82698
			% within Sex of patient	33.0	67.0	100.0
Total	Sex of patient	Male	Count	32554	60483	93037
			% within Sex of patient	35.0	65.0	100.0
		Female	Count	33415	66791	100206
			% within Sex of patient	33.3	66.7	100.0
	Total		Count	65969	127274	193243
			% within Sex of patient	34.1	65.9	100.0

Appendix 4: Seasonality, Malaria test result and the Place malaria test done

Place				TEST RESULTS Negative	Positive	Total
Jordan Hospital	SEASONALITY	Dry season	Count	5575	5487	11062
			% within SEASONALITY	50.4	49.6	100.0
		Wet season	Count	7661	9472	17133
			% within SEASONALITY	44.7	55.3	100.0
	Total		Count	13236	14959	28195
			% within SEASONALITY	46.9	53.1	100.0
Mzumbe Hospital	SEASONALITY	Dry season	Count	29604	12034	41638
			% within SEASONALITY	71.1	28.9	100.0
		Wet season	Count	29056	11656	40712
			% within SEASONALITY	71.4	28.6	100.0
	Total		Count	58660	23690	82350
			% within SEASONALITY	71.2	28.8	100.0
SUA Hospital	SEASONALITY	Dry season	Count	28173	13955	42128
			% within SEASONALITY	66.9	33.1	100.0
		Wet season	Count	27205	13365	40570
			% within SEASONALITY	67.1	32.9	100.0
	Total		Count	55378	27320	82698
			% within SEASONALITY	67.0	33.0	100.0
Total	SEASONALITY	Dry season	Count	63352	31476	94828
			% within SEASONALITY	66.8	33.2	100.0
		Wet season	Count	63922	34493	98415
			% within SEASONALITY	65.0	35.0	100.0
	Total		Count	127274	65969	193243
			% within SEASONALITY	65.9	34.1	100.0

Appendix 5: Informed consent form for research participants

Informed Consent Form (ICF) for the Research on "Knowledge, Control Practices and Transmission Risk Factors on Malaria Among Students of Selected High Learning Institutions in Eastern Tanzania"

Part I: Information Part

I am Mbogo Ng'wisabila Kija, a postgraduate student from Sokoine University of Agriculture at the Department of Veterinary Medicine and Public Health pursuing a Masters of Science in Epidemiology and I hereby to conduct a research entitled **"Knowledge, Control Practices and Transmission Risk Factors on Malaria Among Students of Selected High Learning Institutions in Eastern Tanzania"**. I am kindly inviting you to participate in this research by filling in a questionnaire that has questions seeking to examine your knowledge on Malaria. Part one enquires some of your socio-demographic information whereas the remaining parts are focused on assessing your knowledge on Malaria. The information that will be obtained will be of helpful towards formulating suitable policies for improving health status of students, hence better academic performance towards meeting one's expectations and the nation as a whole. Participation in this research study is voluntary and if you feel that do not wish to take part in it your decision will be highly respected. The filling of the questionnaire may take 15 to 20 minutes and no any payments that shall be provided upon participation. Also there shall be no disclosure of any part of your personal information to third parties and nobody can identify you, and upon completion of the study the results will be published and shared to you with your respective institution and the relevant stakeholders. Before we proceed, do you have any question or need for more clarification?, Are you still willing to take part in this study?..... Good!, lets now proceed to the next part.

Part II: Certificate of Consent

I have been invited to participate in a research about Malaria and its associated factors. To the best of my understanding, I have read the foregoing information and I have had the opportunity to ask questions for clarifications about it and the questions I have been asking have been answered to my satisfaction. Therefore, with all my conscious I consent voluntarily to be a participant in this study.

Name of Participant……
Signature of Participant ……..……..
Date…….……..…….. (Day/Month/Year)

Statement by the Researcher/Investigator

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands what is going to be done. Also I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been forced into giving consent, and the consent has been given freely and voluntarily.

Name of the Researcher/Investigator……
Signature of the Researcher/Investigator …….
Date……..(Day/Month/Year)

CONTACT PERSONS

Would you wish to ask some questions later or any query?, you need not to hesitate to contact the following persons;

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