

Statistical analysis and modelling of the prevalence of malaria in Nyasa district; Tanzania

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Abstract

Background: Demographic, social economic factors influencing the prevalence of Malaria in Nyasa District and the level of knowledge attitude and prevention on malaria disease incurred by the domicile of Nyasa district.

Objective: The demographic conditions affecting the spread of malaria and precautions they take to prevent the disease. Determine the factors affecting the malaria gender-wise.

Methods: A cross-sectional study was conducted using questionnaire on 350 householders selected randomly from two distinguishable wards of Nyasa municipal, Tanzania. Prevalence, incidence, factor analysis to identify knowledge and attitude, binary logistic model on general and gender-wise identifying the significant factors were traced out. Using SPSS 14.5 software model and its adequacy, factors and its validity are verified.

Results: The prevalence rate of malaria in Nyasa is 24.9%, while it is 16.7% in the hills and 36% in sea shores. The ratio of affecting malaria among males and females is 41: 47 and among poor: middle class: Upper class =9.3 :1:0.001. The government provide bed nets for 64.1% but 94% are not getting free hospital facilities. About 90% know that malaria is a transmitting killer disease and its symptoms, preventive measures and mosquito breeding timings. Using bed nets (95%), removing stagnant water (71.7%) and cleaning the environment (62%) are the general measures preferred by people. 17% prefer burning coils or repellents and 28% keep meshes to doors and windows. Child malaria was diagnosed by 61.4% families, If the number of family members is more than 3, the chance for affecting malaria is 0.62, There is a need for hospital stay in many malaria patients (Male 38.8% and Female 47.7%). 95% pregnant woman take hospital advice of which 50% go only in the third month and about 60% are going to know the condition of fetus and mother as well as prevent CDs. 75% of malaria-affected people belong to informal or primary education groups, 89% are poor and 10% are middle-class people. Knowledge of prevention and control of malaria depends on 3 factors use, official service, and self-awareness. Similarly, attitude towards prevention and control also depends on 3 factors- seriousness, lack of awareness, and practicability. Binary logistic model on affecting malaria depends on 5 significant variables – altitude of land, sex, age, income, education

Conclusion: The prevalence of malaria is moderately high in Nyasa compared to the national prevalence rate. Women and children are mostly affected by the disease. Most dwellers were aware of the seriousness of the disease and using bed nets as a preventive measure. People are also keen to destroy stagnant water sources and clean the premises to keep away grass and bushes. The important dependent demographic factors for the incidence of malaria were sex, age, depriving conditions of family, lack of sufficient education and the location of areas like seashores or hills.

Keywords: malaria, prevalence, knowledge, prevention, bed net, demographic factors, social and economic factors

Introduction

Malaria (MOHSW,2008) remains a major cause of morbidity and mortality and more than 600 million cases are reported in each year worldwide with death toll of 2 million cases. Over 90% of these cases occur in sub-Saharan Africa where Falciparum Malaria is pervasive and the major killer of children under 5 years old (Bremam J.G. et al, 2007). Malaria is a major public health concern for all Tanzanians especially for children under age 5 years' and pregnant women. The disease is a major cause of morbidity and mortality among outpatient and inpatient admissions. It accounts for up to 40% of all outpatients visit (MoHSW, 2008). Malaria poses many societal and economic burdens in Tanzania, ranging from school absenteeism to low productivity in the workplace. Combinations of interventions such as the use of insecticide-treated nets (ITNs) by all members, maintaining a clean environment around the dwelling (e.g., by removing items that could hold water and inadvertently serve as mosquito breeding sites), and intermittent preventive treatment (IPTp) for pregnant women, increase the likelihood on malaria prevention and control in the community, (NBS, 2011-12).

The international Roll Back Malaria (RBM) initiative works to reduce the malaria burdens. The primary objective of RBM is to increase access to the most effective and affordable protective measures. The primary objective of IPTp is to prevent malaria-related maternal complications such as maternal anemia and to improve birth outcomes by preventing low birth weight among infants. The strategic plan also includes other vector control measures such as indoor residual spraying (IRS) and epidemic prevention and control. ACT is a response to the emerging resistance of malaria parasites to anti-malarial drugs like Sulphadoxine Pyrimethamine (SP) and Chloroquine, which was used as the first-line antimalarial drugs in Tanzania. But for this time the main medicine which are in use for treatment of malaria are Artemether-Lumefantrine (ALU) which is the first course and if malaria is not solved, then dihydroartemisinin- piperaquine (DP) are used. (Celine I Mandara, Reginald a Kavishe et al, 2018).

The rationale behind the study was to assess the prevalence of malaria in the demographic, socio economic and environmental conditions leading to malaria infection and the knowledge, attitude and practices of people of Nyasa over the disease. The objective of the study was to assess The demographic conditions affecting the spread of malaria. The feeling of people on affecting malaria and the general precautions they take

The extension of government and health caring system to reduce the prevalence of malaria. In Tanzania, prevalence of malaria has been decreasing from 10% in 2008 to 9.5% in 2012. The study points to one major success in the scheme: health workers reported that the number of malaria patients and the number of severe malaria cases had declined in Ruvuma Region. (Komba A. 2008).

Prevalence of malaria in Tanzania for the last 20 years is decreasing due to the vector control methods adopted by the government of Tanzania with the help of international agencies, still some area in Tanzania shows higher percentage than the prevalence rate of the nation. (NBS 2011-2012). Nyasa is one of the areas where such cases of malaria are found in the colonies. So the study was to concentrate on formulation of statistical model of prevalence of malaria so as to determine the prevalence of malaria in Nyasa District. Demographic factors like sex of respondents, age of respondents, place of residence, level of income, and level of education with malaria cases had influence on prevalence and spread of malaria.

Demographic factors:

Sex: Gender plays a greater role in the prevalence of Malaria in Districts, regionally, nationally and internationally. Female are the one who often experience the impact of Malaria more severely than

male due to a combination of social and economic constraints and pregnant women tend to reduce their immunity to fight against malaria (NBS, 2011-12). In Fako Division, South West of Cameroon, a study was conducted by (Ndamukong-Nyanga J.L. et al (2014)), on socio-demographic and environmental factors influencing asymptomatic malaria and anemia incidence among school children. The result shows that the incidence of asymptomatic malaria was 43.4% (CI=38-48.9) and commented that malaria parasite incidence was higher in female.

Age: Children are at highest risk of infection, especially under 5 years, because, their white blood cells are not matured to fight against diseases. Age is an important factor in determining levels of acquired immunity to malaria, (Doolan et al, 2009). Also Amusan O.V, (2017) discovered that immunity is good in 21-30 years (31.8%), 31-40 years (23.8%), and the best in 15-20 years (3.4%). Malaria incidence was significantly highest ($\chi^2=7.1204$, p value= $0.03 < 0.05$) in pupils of 6-10 year' age group (49.0%, CI=42.1-59.9) compared with their counterparts.

Place of residence: Among the place of residence, rural areas are at higher risk of being affected by Malaria compared to urban. (Smithson P (2009). However, school surveys in Dar-Es Salaam during a dry spell in 2003 showed that the prevalence of malaria parasites was low: 0.8%, 1.4%, 2.7% and 3.7% in the centre, intermediate, periphery and surrounding rural areas, respectively. Also place of residence can be categorized as low and high land in which malaria occurred high in low land compared to other lands (Mboera et al 2008). A study was conducted in Iringa District, Tanzania among school children within six villages classified into three categories lowland, intermediate and highland and it was established. In a study of Usambara Mountains in north-east Tanzania, a prevalence of malaria in children were observed to decrease by 5% for every 100 m increase in altitude from 82% in the lowlands (at 300m) to 12% in the highlands –(at 1700m) (Bodker. R, 2006). In another study in northern Tanzania (Drakeley CJ, 2005) a 19% to 21% decrease in malaria prevalence has been observed, for every 100m altitude increase. The lower malaria prevalence in the higher altitude is likely to be attributed to the low ambient temperatures (Khaemba B.M,1994). Altitude has been considered as a proxy for temperature on the parasite. However, local variations in seasonality of malaria transmission including vector species composition, topography, host and parasite genetics, and socio-economic factors influence malaria prevalence in any given area (Lindsay. S.W,1996).

Level of education: Most expected thinking is that the educated people prefer more the practices of prevention and control of malaria compared to illiterate. Also children whose mothers have no formal education or who have not completed primary school are more likely to be affected than those whose mothers have completed primary school (NBS, 2011-12). A logistic regression model was used to assess the association between the educational level of patients and malaria infection, the association was significant (Shr-Jie Wang et.al, 2006).The head of the households' level of education had an influence on bed-net retreatment ($p=0.0000 < 0.001$) and acceptability of larval control program ($p=0.0000 < 0.001$). In addition, the education level of the household heads played a role on understanding the causes and selection of malaria interventions for the households (Lowassa A, 2012).

Level of income: Among two categories, level of income below 100000Tshs per month are in higher risk of being infected by malaria because they face difficulty to purchase the materials needed for prevention and control of malaria (example bed nets). (Mboera L et al, 2013). The poor people living in a house built with leaves and mud had a higher risk of having malaria compared to those living in a house built with brick and/or concrete (OR = 21.8, 95% CI = 1.29–369.65, $p < 0.05$). (Shr-Jie Wang et.al,

2006). A significant association was observed between bed-net retreatment, larval control and occupation of the head of the household (Lowassa A. 2012).

There are several studies conducted which focus on the prevention and control of malaria as elaborated below. Sumari *et al.* (2016), conducted a study on knowledge, attitudes and practices on malaria prevention in secondary students Bagamoyo, Tanzania. A sample of 125 children were searched and found that more than half, (63.2%) of school children had knowledge on malaria as a disease and its transmission. A large size -101 children reported that they are going to hospital immediately, when they feel malaria symptoms and avail ALU treatment. Cleaning environment to prevent mosquitoes from breeding, use of bed Nets (LLINs), Indoor Residual Spraying (IRS) and the use of chemotherapies are different practices they undergo to save from this vector. (115 out of 125, 92%).

Mazigo D.H *et.al* (2013) conducted a study on knowledge, attitudes and practices about malaria prevention and control in the rural area of Geita district, north west of Tanzania. 56% of household heads had knowledge on prevention and control of malaria and most prefer personal protection against mosquitoes by ITNs (77.3%). 86.3% agree with IRS of insecticides, and suggested that education should be provided to the communities. According to Amusan O.V, (2017) a study on knowledge, attitude and practices on malaria prevention and control among private security guards within Kaduna Metropolis, Nigeria was conducted with a sample size of 261 guards. There are 96.94% respondents with a high knowledge about malaria, 78% with a positive attitude, 74% with good malaria practices and 96.9% correctly associated mosquito as malaria vector. Wearing long-sleeved shirts, trimming of bushes and use of ITNs are the leading malaria prevention methods practiced by the respondents. Statistically significant association between malaria practice scores and respondent's age ($\chi^2=5.2457$, p value=0.022<0.05), gender ($\chi^2=9.5495$, p value = 0.002<0.05) and level of education ($\chi^2=7.5503$, p value = 0.006<0.05) was reported. Respondent's knowledge about malaria ($\chi^2=7.0334$, p value = 0.008<0.05) and attitude towards malaria ($\chi^2=5.4118$, p = 0.020<0.05) were found significantly influence their practices towards malaria.

Methodology

Population and Sample

A random sample of 350 persons living in Nyasa region were interviewed with a structured questionnaire containing questions regarding the means of protection from malaria, knowledge/awareness about the disease, attitude on treatment and severity of malaria, need of hospital facilities, severely affected groups as well as the social and demographic constraints of the informants. Factor analysis was applied to identify the factors on awareness and attitude. Logistic regression model was adopted to identify the incidence of malaria on social and demographic factors. Odds ratio was used to find the significant variable and model adequacy was confirmed by Hosmer and Lemeshow test. Effectiveness of governmental health activities on people of Nyasa is evaluated using Chi Square test. General binary regression model as well as male and female model were developed with respect to social, geographical and personal factors influencing incidence of malaria.

Statistical Methods

The data was cleaned by fixing outliers and missing information and prevalence of malaria, social and educational background of the house holder and hygienic conditions of house premises were derived by qualitative analysis. Also the knowledge and attitude towards malaria by the residents were formalized by detecting factors. The logistic regression was applied to determine the factors for infecting malaria separately for man and woman. Normal test, Chi square test, Odds ratio, factor

analysis and fitting binary logistic regression models were the statistical tools administered to elicit results.

Factor analysis

Correlation analysis (>0.6), determinant (0.099≠0), KMO test (0.674>0.6), Bartlett’s test ($\chi^2=798.45$, p value=0.000) are adopted to restrict the variable for factor analysis. Scree plot with Eigen values >1, PCA method of extraction, Vari-max rotation method, ignoring coefficients with communality < 0.5, total variance explained 72.45% were adopted to get the optimum factors.

Logistic regression model

$$\text{Logit}(Y) = \log_e(\text{odds}) = \ln\left(\frac{\pi}{1-\pi}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_p X_p \dots\dots\dots(1)$$

the probability of occurrence.

$$\pi = \frac{e^{\beta_0 + \beta_1 X_1 + \dots + \beta_p X_p}}{1 + e^{\beta_0 + \beta_1 X_1 + \dots + \beta_p X_p}} \dots\dots\dots (2)$$

β_0 is the Y-intercept, $\beta_0, \beta_1, \beta_2 \dots \beta_p$. are regression coefficients and $X_1, X_2, \dots X_p$ are explanatory variables. This model could be used to predict prevalence of malaria. In particular

$$\text{Logit}(\pi_j) = \beta_0 + \beta_1(\text{age}) + \beta_2(\text{sex}) + \beta_3(\text{residence}) + \beta_4(\text{education}) + \beta_5(\text{income}).$$

Odds Ratio

The Odds Ratio is greater than one, indicating that the likelihood of the occurrence of success is higher, while an odds ratio is less than one, shows the opposite effect and if the odds ratio is equal to one, it shows the occurrence of two outcomes equally likely.

Results

Prevalence of Malaria

The general prevalence of malaria in Nyasa district was 24.9%. Prevalence in lower and upper areas of Nyasa significantly differ from Tanzanian rate of infection. There was an occurrence of 20% more cases of malaria in the lowland areas of Nyasa compared to highland areas. (Using Normal test, $Z=0.6563$ p value=0.5116>0.05). There was significant difference in the rate of incidence of infecting malaria between male and female inhabitants (0.42 in male & 0.4771 in female) ($\chi^2 =10000$ p value 0.0000<0.05). But the average number of male and female members infected malaria was equal ($Z=0.0002$ p-value =0.9998>0.05). Availing information on child incidence of mortality and morbidity due to malaria from the informants, the incidence of malaria under 5 was only 33%. But neonatal mortality was 13.12%, under 5 mortality- 10.5% and it was found that most of this was happened in primary educated or illiterate mother’ child of lower strata of economy.

Hospital visit depends on distance of availability of hospital and 2/3rd favor at least a PHC within a distance 1KM. But 35% to 45% are visiting the hospital by travelling more than 1KM from the house. Thus visit to hospital is affected on getting treatment to malaria ($\chi^2=10.517$, p value<0.005). 2/3rd agree that the government provide awareness through health professional but only 15% are participating in the awareness programs. Males and females differ on government programs success on malaria

($\chi^2=4.088$, p-value $0.043<0.05$). 85% of educated categories avoid the awareness camp. 80% respondents told that hospital service is costly and the average cost for hospitalization is about 10000 Tsh. Free nets are getting among 65% poor, 76% of middle class and 50% of upper middle class. 94% of the poor and 85% of the middle class did not get free medical services in hospital after being affected by malaria. Free service by health department is not provided with respect to the economic condition of the family ($\chi^2=4.438$, p value= $0.109>0.05$). The cost of treatment on various areas of Nyasa was identical ($\chi^2=0.009$, p value= $0.925>0.05$).

Knowledge, Prevention and Control

The knowledge about malaria as a transmitting vector was found in more than 95% of inhabitants of Nyasa but the knowledge on prevention is significantly different in males and females. ($Z=6.4571$, p-value= $0.0000<0.05$). Feeding time of mosquitoes is known by 87% of participants and identification of malaria symptoms is done by 89%. 7% females and 3% males were not taking any preventive measures to restrict malaria. 79% residing here were taking initiative to drain out stagnant water from living premises while 65% are constructive to clean the environment.

No significant difference was found among males and females on using mosquito net as a preventive measure ($Z=0.6543$, p value= $0.5128>0.05$). Significant difference of opinion was found in males and females on removing dirty water as a prevention ($Z=2.8079$ p-value = $0.0049<0.05$). Only 7 respondents in Lipingo region (High altitude) and 10 in Kingerikiti (Ocean region) were not taking any preventive measures. There was significant difference by the Lipingo and Kingerikiti people in using mosquito net as a protection. ($Z=6.1974$ p-value = $5.74E-10<0.05$). In the low land 96% use bed nets and the use of net was not depending on the education level of the respondent. It is alarming that 15 out of 240 primary educated and 2 of 80 secondary educated respondents do not take any preventive measures.

More than 60% of respondents irrespective of their educational level were eager to avoid dirty water logging in the premises to avoid spread of malaria. Only 10% of poor are using repellents or coils while 25% opted to close the doors to save from mosquitoes. More than 10% use gauze wire windows while 3.5% do nothing to prevent mosquito spread. Using coil and gauze wire windows were the strategy mainly considered by upper class. 10% use coils, 25% prefer closing doors, 15% use gauze wire windows. 231/350 (67%) are diagnosing child malaria confidently and handle it well. Only 2 respondents were interested on traditional medicines as treatment for malaria.

Rate of patients taking hospital service after infected malaria in Lipingo area is 0.73 (males) and 0.9 (females) while it is 0.39 (males) and 0.41 (females) in Kingerikiti area. Comparing the incidence of malaria on poor category dwellers of Nyasa, males were less affected. (males= $134/295=45\%$, females = $147/295=49.8\%$). Similarly, among the middle class families only 29% males were infected by malaria while it was 46% females.

More than 60% of houses of more than 4 members were affected by malaria. Thus there is a direct proportion of infecting malaria with number of members in a family ($\chi^2=5.265$, p value $0.072>0.05$). 49% affected in families with 1-3 members and it is 60% in families with members >3 . Most of the pregnant women (19/20) are visiting hospital in Nyasa during pregnancy. 50% pregnant women are visiting the hospital on third month. 9/20 visits hospitals during pregnancy to get education about ways of life and precautions to be taken at such time. 60% go to know the growth of fetus and condition of themselves. 11/20 visit to prevent and control disease like malaria. Traditional protection from malaria was realized by 7% in Lipingo and Kingerikiti. 1/17 families of non-formal and 3/13 of higher educated people were using traditional methods to protect from malaria. Incidence of malaria in lowlands and highlands are significantly different ($Z=152.23$, p value = $0.0000<0.05$).

Education has significant influence on the practices of prevention and control of malaria. ($Z=2.4089$, p -value is $0.008 < 0.05$). Level of income was categorized into three - poor, middle and upper. Families of different income groups differ significantly in Malaria infection ($Z=2071.22$, p -value $0.000 < 0.05$). In the Lipingo ward (Low level), 44% of families were affected badly by infecting malaria while 32% were partly affected and 24% were not affected. It is notable that in the hilly region, 22% of male and 10% of female respondents were infected by this vector. In Kingerikiti (high land) 53% of families were not infected, 28% partly infected and 19% were highly infected. About 15% of males and females were infected in this region. Low land wards were pro malaria infectious compared to high land wards of Nyasa district. More than 50% families in the Kingerikiti highland region is not infected by the disease but it is only 25% in Lipingo low-lying ward.

For the question “Do you know the ways of prevention and control of malaria?”, 95.1% of the respondents affirmed yes and ascertained that the participants were using one or other methods to keep away malaria. This is an indicator of seriousness of the vector over the Nyasa District of Tanzania. There is no significant difference in the rate of contracting malaria between males and females who were not taking any precautions against the disease. ($Z=1.0943$, p value $=0.1369 > 0.05$).

All of the young respondents aged between 25—55 year aspired the need that the government and other agencies should act more actively to eradicate the disease. All higher educated respondents are using preventive measures but 15 of 17 primary educated are not using any such methods and it is grave. Barring one, all the non-net-users belong to poor families indicating the need of supplying bed nets or other facilities free of cost to poor by the government and international health organizations. Only 5% of respondents do not use bed net, while 40% were not interested in cleaning environment and 30% were not removing dirty water, creating spread of mosquitoes in the region. So social awareness program is essential to improve the hygienic conditions of Nyasa District. Considering personal healthy practices 94.6% adopt bed nets and 28% close doors and windows and 14% use gauze wire in windows.

About 97% agree that malaria is a life threatening disease. Out of it 60% were much worried about its propagation and health care. About the transmission of malaria from one person to another, 40% agree on it, while 50% disagree and the rest had no idea about it. 90% agree to avoid mosquito bite to protect from malaria. Infection of malaria is unpredictable and it can be infected at any time to anyone. This is the feeling of 88% Nyasa people indicating the fear of contracting malaria in that area. About 30% of respondents are strongly against treating malaria by themselves and require treatment by suitable healthcare units. Another 42% are also not convinced of self-medication.

Pregnant women and children are most suffered by malaria (97%) and the mortality rate is high in this group. As per opinion of 89% respondents, it is certain that malaria requires proper care and medication and if not treated properly on time it will be life threatening. 48% of respondents believe that the work at night in gardens and forests will expose to malaria of which 28% are sure of contracting it. Appropriate medication is essential to recover from malaria according to 93% of Nyasa people showing the need of giving hospital facilities and free medicines. Nyasa people were not keen on buying drugs or taking medicine (72%) indicating the lack of seriousness or the poverty inhibited on them. 91% like to go to health enter or clinics to check the infection of disease immediately after showing symptoms of malaria. The expiry date of medicine is checked by 92% of respondents and it is a good sign about the awareness of medication in proper way. Thus Nyasa people are moderately aware and serious about the danger of contracting malaria. Also they like to get more clinical and health centre care to treat the disease. Most of them oppose self- treatment or lack of treatment, but they are in need of awareness on anti-mosquito bite drive.

Knowledge of prevention and control of malaria

Net use= $.398*\text{sleep in net}+0.41*\text{members sleep in net}+0.309*\text{repairing net}$ (3)

Official Service = $0.614*\text{spray}+0.609*\text{visit VHT}$ (4)

Self-awareness= $0.769*\text{clean water}+0.493*\text{visit HC}$ (5)

Knowledge =average (net use +official service +self-awareness) (6)

Since all values of Cronbach's Alpha are >0.6 , the factors show consistency and reliability.

Average response on net use is 1.4 with low SD showing consistent opinion of use of bed net. Official service had a fair average 3.04 indicating that most of respondents are approving the activities of government, but SD is high. Self-awareness has average 1.64 showing need to improve by Nyasa people. Overall knowledge displays an average 2.02 implies that average knowledge level should be improved for prevention of malaria in Nyasa. There is no significant difference in the opinion of net use and government services in different wards, but self-awareness and knowledge on prevention are significantly different in these wards. The official service and self-awareness were significantly different in different economic groups ($Z=2.0489$, $p\text{ value}=0.008<0.05$ and $Z=1.8521$, $p\text{ value}=0.032$ respectively).

Attitude

There are 3 independent factors to identify the attitude and such model contains more than 55% variability of responses of population.

Seriousness= $0.366*\text{dangerous on not completing medicine}+0.477*\text{immediate checkup}+0.444*\text{medicine before expiry}$ (7)

Lacking awareness= $0.626*\text{self-treatment}+0.592*\text{drug from un authorized source}$ (8)

Practicability= $0.622*\text{life threatening}+0.566*\text{save from mosquito bite}$. (9)

Attitude=average (seriousness+ lack of awareness+ practicability) (10)

Seriousness had a mean response 3.24 with $SD=.66$ so that on average respondents agree with the need of seriousness. Lacking the awareness had mean 2.57 indicating lack of seriousness by the people of Nyasa. Practicability with mean 2.99 agrees that malaria is life threatening and avoid mosquito bite. Overall attitude takes an average of 2.93 with $SD =0.47$ implying a fairly agreeing attitude on prevention and control of malaria. Seriousness, practicability and attitude are significantly different in Lipingo and Kigeriketi ($Z=1.9953$, 2.6520 , 2.7477 , with respective $p\text{ values}=0.023<0.05$, $0.004<0.05$, $0.003<0.05$). Seriousness and attitude are significantly different in males and females ($Z=2.6520$, $Z=2.09620$ with respective $p\text{ values} 0.0004<0.05$, $0.018<0.05$). Seriousness is different in different age groups ($Z=3.0902$, $p\text{ value}=0.001<0.05$) and lacking awareness also differs on ages ($Z=1.8384$, $p\text{ value}=0.033<0.05$). Attitude is different in various ages ($Z=2.8781$, $p\text{ value}=0.002<0.05$) but practicability is identically classified by all ages ($Z=0.8632$, $p\text{ value} 0.194>0.05$).

General model-regression output

The model satisfies Lemeshow test = $0.449 > 0.05$ and hence goodness of fit. From this model, the odds of being infected by the epidemic in the old ages was 1.373 times higher than younger ages. Regarding sex, the likelihood of being infected by malaria was increased among the females than males in Nyasa District (Odds ratio = 1.590). The odds of being infected by the epidemic was 3.509 times higher for Lowland compared to Highland. The model also showed that the odds of being infected by Malaria in educated group was significantly less compared to illiterates. Odds was 1.693

times higher for illiterates. Also, the odds for the low income group of people to the upper income group is 2.257 showing higher occurrence of malaria among the poor.

In the male and female models there is significant difference in the coefficients of age, ward, education and income. ($Z=4.8877, 40.5222, 26.9327, 35.2661$ with p values $2.5896 \times 10^{-6}, 0, 1.2266 \times 10^{-158}, 3.4189 \times 10^{-271}$ respectively). Also odds ratio predicts high influence of malaria in low lands and it was too much in females. For education, much influence was on lack of education, especially among women. But in the income groups, low income group had more effect, especially in male model.

Thus general model and the gender model emphasize the need of awareness through education and improve poverty conditions to eradicate malaria in Nyasa. The low lands require more attention on malaria prevention projects.

Discussion

Prevalence

Statistics & facts in Tanzania by severe Malaria observatory, USAID report on Presidents Malaria Initiative, UNICEF data on Malaria, WHO report on Malaria prevention, Tanzania and the DHS program for Malaria indicator survey, the following results conclusions and expectations were made on 2017 up to 2022 studies. 16% of all the outpatient visits in mainland Tanzania is due to malaria and 93% are living in malaria transmission areas where this study shows that Ruvuma region is also an area of high risk of malaria. Tanzania is one among 10 countries with highest malaria cases and 3.1% of global death cases and 4.1% of global deaths in 2021. During 2020-2021, incidence rate at risk increases by 2.1% from 123 to 126 per 1000 of the population although the death rate decreased by 1.7 per thousand. In 2017, under 5 mortalities was 5%, with incidence of malaria 37% and neonatal mortality was 9%.

Tanzania has recorded a 10 percent decline in malaria prevalence from 18.1 percent in 2008 to 8.1 percent in 2022, according to new statistics from the ministry of Health. The National Malaria Control Programme wants to eradicate malaria by 2030 by reducing the prevalence in children under the age of five to less than 3.5 percent by 2025. The number of people living in areas free from malaria infection increased from four percent (2008) to 41 percent (2022). The number of confirmed malaria cases has declined by 55 percent from 7.7 million in 2015 to 3.5 million in 2022.

Incidence per 1,000 people, has reduced by 64 percent from 162 in 2015 to 58 percent in 2022. Hospital admissions due to malaria cases have decreased by 66 percent from 529,146 in 2015 to 178,549 in 2022, which indicates a decrease in severe cases. The number of malaria deaths recorded in health facilities has decreased by 76 percent, from 6,311 in 2015 to 1,502 in 2022. The new stratification (2022) shows an increase in the number of councils with very low malaria transmission risks from 36 (2020) to 38 (2022) and a decrease in high burden councils from 64 to 57. Data indicates that the central regions of Dodoma, Singida, Manyara, Arusha, Kilimanjaro and Songwe have zero percent prevalence in 2022, Mwanza, Iringa and Dar es Salaam have only one percent. Highest rate was in Tabora (23.4), Mtwara (20), Kagera (18), Shinyanga (16), and Mara (15). Prevalence of malaria is higher in rural areas (10%) than in urban areas (less than 1%).

Prevalence of malaria in children ranges from less than 1 percent in every region in Zanzibar, plus Arusha, Kilimanjaro, Manyara, Dodoma, Singida and Songwe but 20% in Mtwara and 23% in Tabora. In 2017, Under-5 mortality was at 5% while neonatal mortality (under 12 months) was at 9% with incidence of under 5 cases 37%. In the same year, prevalence on mainland varied by region from <1% in the high lands of Arusha to as high as 15% in the southern zone and 24% along the Lake and western

zones. According to DHS, Urban resident's prevalence of malaria is 0.7% while for rural residents it is 10.4%. Also the topography of land influences the prevalence of malaria as southern highlands at 4%, southern lands at 15.7%, south west highlands 3.9% Lake 11.5%.

Prevalence in Nyasa region under this study

The results show that the general prevalence of malaria in Nyasa district was 24.9% which implies that out of 1644 household members there were 409 household members were affected by malaria within the six months (from November, 2017 to April 2018).

Prevalence of malaria in Kingerikiti ward located at highland area of Nyasa was 16.7% while in Lipingo ward located at lowland area of Nyasa was 36%. There is 20% more cases of malaria reported in the lowlands of Nyasa compared to highlands. The rates are a little high in this study as sample size was limited to 350 only. This study mention that 76.2% malaria affected cases were from low educated people, 56% domicile in sea land, 89% from poor economic conditions, and out of 350 houses 210 (60%) were affected of which 49% were affected for both male and female in a house, while 31% males and 20% female only were affected in some houses.

Overall, incidence of malaria diagnosed per 1000 person years was 735 among females and 449 among males (IRR = 1.72, 95% CI 1.68–1.77, $p < 0.001$), with larger differences among those 15–39 years (IRR = 2.46, 95% CI 2.34–2.58, $p < 0.001$) and over 39 years (IRR = 2.26, 95% CI 2.05–2.50, $p < 0.001$). Here as in Tanzanian statistics, female occurring malaria is more 0.4771 over male 0.42 in Nyasa with IRR= 1.143. Thus the IRR is less in Nyasa showing less difference in male and female prevalence compared to national level.

In 2017, under 5 mortalities was 5% with incidence of malaria was 37% and neonatal mortality was 9%. In this study the neonatal mortality is high, 13% and under 5, mortality is 10.5 which may be due to topographical, lack of education and low level of economic conditions but the incidence of malaria under 5 was only 33%, less than national level.

Ownerships of ITNs has steadily increased in Tanzania, reaching a peak of 92% of households with at least one ITN in 2011-2012. But in 2017 it was only 78% and improved in subsequent years to 84%. This study exposes a high rate of using bed net (94.6%) as best prevention measure to curb malaria. Free bed nets were supplied only to 67% of house holder of the survey. 54% children and 51% pregnant women slept under bed nets in 2017. Prevalence of malaria in pregnancy is much higher in girls and women aged 15–19 years and decreases with each subsequent pregnancy.

The disease is also much more prevalent in women living with HIV regardless of the number of times they have been pregnant. In this study, 55% pregnant woman only visit hospital for getting treatment and prevention for malaria and 62% pregnant woman are using bed net. Wealth quintile also affect the infection rate as lowest 14.5%, Second lowest 10.9% and middle income 7.9% are highly affected by malaria while in Nyasa 41% poor and 10% middle class were hit by malaria.

Knowledge, attitude and practices about malaria

In a study by David. Z Munisi et al (2019) in pub med journal, out of a total of 295 samples of symptomatic patients in Tumbi Referral Hospital, 93.9% were aware of malaria and 95.31% knows that it is transmitted by mosquito. Only 65.8% were taking proper medication but all are likely to sleep under bed nets. In this study, 97% agree that malaria is a life threatening disease and 60% is of strong opinion. Transmitting malaria from one to other is not having a unique opinion among respondents - 50% are disagreeing while 40% are agreeing and 10% does not know about it. 90% believe that avoiding mosquito bite, malaria can be avoided. Only 94.6% are using bed nets and 2% did not take any

prevention. 95% are aware of malaria infection and prevention measures but 2% men and 3% women are not much aware of this problem.

Another study on knowledge, attitude and practices on malaria infection in Massi and Nanyumbu districts, Tanzania, (Billy Nagasala et al.2023), 1556 household heads were interviewed and all had knowledge of malaria but 47.33% had moderate and 13.83% had high knowledge, 83.87% had bed nets. Knowledge on malaria was influenced by gender (aOR=0.72, p-value 0.03<0.05), level of education (aOR=1.50) and occupation of house holder (aOR=1.90). A study on Tanzanian college students, (Yakobo, Nyahoga 2018), searched the knowledge among students of UDOM, 246 students were taken for opinion. 34 to 40 students from each college, 89.4% prevalence was reported and 98% were confidently told about the vector and 87.8% about prevention. 65.8% identified plasmodium as the intracellular parasite, while 24.6% believed it as bacterium and 8.8% as virus. Only 44.7% used bed net in the campus and 13.4% use anti mosquito sprays or ointments, 76.4 % agreed that ITN is best to prevent malaria. Comparing with this study, our study results that house holders of 60% of male, 51% of female, 95% of age group 25-55 years, 93% of primary or low level education, 94% of poor in the survey are having good knowledge of prevention and control of malaria.

In Lindi urban region, Tanzania, in a knowledge study about malaria control, 89.6% agreed that they knew causes of malaria, but 64.2% only think that mosquitoes were the reason for malaria. 22.5% believe that untreated nets will also leads to mosquito bite and malaria, 41.7 % identify themselves affecting malaria without testing, but only 33% go for test, 7.53% go for traditional treatments, 87.9% seek hospital treatment, 56.7% want to use treated bed nets, 14.6% for household cleanliness and 17.8% clearing bushes to reduce malaria. But in this study 7.4% seek traditional treatment, 71.7% for draining water and 62% for cleaning surroundings to reduce malaria spread.

In Karatu district a study on pregnant women, 80% only identify mosquitos as cause, 81% identify malaria as the most common disease in their area. In the age group of 16-20years pregnant women, 24/30 (80%) has adequate knowledge. In the age of 21-30 years, 47/62 (75.8%) had knowledge, while in more than 30 year pregnant women, 19/22 (86%) had good knowledge on malaria but among the illiterate women, 10 out of 16 (62.5%) were not aware of malaria effect and causes. 26% want immediate treatments on symptoms of malaria, while 42% were going to treatments only after 3 days of onset of symptoms. Another study on rural eastern Tanzania, 243 samples were taken, 53% identify Anopheles mosquitoes was responsible for malaria. They feel that under 5years children, (61%) were most vulnerable, 64% rely on ITNs as prevention for malaria. The mosquitoes were entered through widows (46%) by eave opening (10%) and 4% by wall cuts. 58% attend night time out door gatherings, 77% cooking outdoors, went to bed only after 8 pm.

Comparing with this study, our study exposes 28.9% close the doors window all time and 14.4% use gauze wiring on windows to prevent mosquitoes. Only 67% are capable of diagnosing child malaria by which vulnerability is much higher in Nyasa for children especially under 5. Among the higher education students in eastern Tanzania, in a dissertation 58.8% of respondents had less knowledge about malaria disease, in which female are more (46.5% of female and 35.9% of male) and malaria control practices were taken only by 25 %. But males were affected more in the campus due to their resistance to take preventive measures. Among the students only 31.9% identify the symptoms and 42% only use bed nets, 23% dislike it, not able to buy 20.6%, suffocation 14.6%. Only 38.7% use long clothes in the bed, while 69.3% apply self-treatment and getting complicated. In the wet season in SUA 11072 Anophelene and 3620 Cluecine larva was found in the premises of campus by which the prevalence rate was 34.1% with 2.6% more in wet season.

Thus the prevalence and knowledge attitude on prevention of malaria is moderate in Nyasa people and they are also in need of government healthcare services to improve and save from the disaster due to malaria.

Conclusions

This study enlightened the demographic, social and personal factors influencing malaria like sex, education income. It alerted the prevention by government system and self-hygiene to protect from the disease. Women and children under 5 were expose to contract the disease along with pregnant women. Awareness and attitude towards treatment and precaution should be revamped. Bed nets, closed windows and gauze wires usage should be inspired. Medical care centers with low cost and free of cost should be available within 2Km to help many Nyasa inhabitants. Prevalence of malaria is very high in Nyasa region compared to Tanzania rate of incidence and special care should be given on improving the basic health and poverty in this region.

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Competing Interests

I hereby declare that there is no competing interest by any other authors or researchers or agencies on the results.

Tables and Figures

Table:1 Patient Statistics of malaria in Ruvuma and Nyasa				
Place	Age (Years)	No. Malaria Cases	Proportion (%)	Ratio
Ruvuma Region	0-5	171433	40.7	2/5
	>5	250053	59.3	3/5
Nyasa District	0-5	16104	43.9	9/20
	>5	20580	56.1	11/20
Nyasa District Hospital	0-5	1152	36	1/3
	>5	2088	64	2/3
Source: Ruvuma Regional Hospital				

Table 2: Prevalence of malaria at a glance			
% Prevalence of malaria			
Tanzania	Nyasa	Lipingo	Kingeriketi
9.2	24.9	36	16.7
p values		0.0000	0.0000

Table:3 The regression output-general						
Variable	B	S.E.	Wald	Df	Sig.	Exp(B)
Wards	1.255	0.253	24.67	1	0	3.509

Sex	0.528	0.242	4.751	1	0.029	1.59
Age	0.317	0.111	8.079	1	0.004	1.373
Education	0.527	0.207	6.445	1	0.011	1.693
Income	0.814	0.261	9.743	1	0.002	2.257
Constant	-2.305	0.445	26.829	1	0	0.1

Table 4: Male and Female model-regression output.

Variable	Male B	Sig	Female B	Sig.	Exp(B)	Exp(B)
Age	0.229	0.032	0.258	0.018	1.258	1.294
Wards	0.927	0	1.475	0	2.528	4.373
Education	0.393	0.051	0.691	0.001	1.481	1.997
Income	0.977	0.002	0.485	0.063	2.657	1.624
Constant	-1.234	0.001	2.16	0	0.291	0.115

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