Original Article

Magnitude of Malaria and its Associated Factors among Febrile Patients Aged Five Years and above: A cross-sectional Study in Ngoma District, Rwanda

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Abstract

Background
Malaria remains a public health challenge among people aged five years and above. Despite the efforts made by the government of Rwanda in malaria control, the burden of malaria continues to be a health threat among humans aged five years and above

Objectives
To assess the prevalence and factors associated with malaria among febrile patients aged five and older in Ngoma District, Rwanda.

Method
A facility based cross-sectional study was conducted among 420 participants using a systematic sampling technique. Blood smears were tested for malaria parasites and questionnaire used for other data collection. Analysis was done using STATA version 13.0. Multivariable logistic regression analyses were computed to determine factors associated with malaria infection at 95% confidence intervals and statistical significance at $p< 0.05$.

Results
Among participants, 60.7% were females, 35.9% were of 35 years and older, Malaria parasites were identified in 257 cases (61.2%). Malaria positivity associated with age ≥35 years (AOR=3.6; CI=1.3-10.02; P=0.012) and living in Mutenderi Sector (AOR=3.15; CI: 1.2, 3.9; P=0.038).

Conclusion
Malaria prevalence was considerable and people living in Mutenderi Sector were more likely to suffer from it. Need of strengthening Malaria prevention in older people and in Muteneri Sector in particular.

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Keywords: Malaria, parasites; Prevalence; Febrile, Factors; positivity.

Introduction

Globally, malaria caused approximately 627,000 deaths of which 96% occurred in the African region during 2020.[1] In Sub-Saharan Africa (SSA), estimated malaria prevalence is 30%, and its transmission is facilitated by the loss of indigenous forests. [2,3] Children younger than five years of age have the highest severity of malaria infection, but adults have highest prevalence with a high likelihood of being asymptomatic and sustain transmission of infection. [4,5] Despite the effort made in malaria control and prevention, the malaria burden continues to be a major health threat.[6] It has been noted that malaria can cause an average of 3 days in unproductive conditions to an individual, with an additional indirect cost of around 10.85 US dollars in adults. [7]

Most malaria prevalence studies available have focused on children younger than five years, pregnant women, and HIV infected persons. Consequently, published studies of parasitaemia in the general population aged five years and above are very limited. [8] Malaria prevalence in age groups other than children younger than five years is of scientific interest because this group of people could form a community reservoir of parasites for younger than five years. [9] The study done in Tanzania by Winskill demonstrated that ages five and older were at higher risk of malaria than children younger than five.[10,11]

In Rwanda, malaria control and prevention measures are integrated throughout the entire health system, from community to central levels. The major changes include: Introduction of Home Based Management (HBM) in 2004,[12] shifting from Amodiaquine and Sulphadoxine - Pyrimet on therapy in 2006,[13] integration of the community health worker's services in Rwanda Health system in 2007, and lastly the use of indoor residual spraying in endemic areas during 2010.[14]

The scope of work for community health workers was also extended from children under five years of age to include adults to ensure that malaria is managed at the community level.[15]

In 2016, the increase of malaria cases and deaths was around 4.5 million and 715 respectively.[12,13,17] The prevalence of Malaria in Rwanda increased from 48 per 1000 people at risk in 2013 to 403 in 2016. [16] With reference to the 2016 Malaria & other Parasitic Diseases Division (MOPDD) annual report, malaria had largely increased in people older than five years of age compared to those younger than five.

Though malaria prevalence has increased, there are limited studies published about malaria in those above four years of age and in the Mutenderi study area. The aim of this study was to access the prevalence of Malaria and the factors associated with it among individuals aged five years and above. The study had the following research questions: What is the prevalence of Malaria among people aged five years and above who are presenting with malaria-like symptoms? What are factors associated with Malaria among febrile patients aged five years and above in Ngoma District?

Methods

Study Setting and Population

The study covered the period from November to December 2018 among febrile patients aged five years and above attending public health facilities: Kibungu Referral Hospital and 12 Health Centres in the Ngoma District of the Eastern Province in Rwanda. Ngoma District is a malaria endemic area and has about 338,562 inhabitants.[18] Annually, Ngoma District, like the rest of the country, experiences two rainy seasons (October to December, and March to May), and two dry seasons (January to February and June to September). In some areas of Ngoma district, there are wetlands especially along rivers, and around lakes.

Study design and sampling techniques

This was a cross-sectional study design and a systematic sampling method was used. The study participants were individuals aged five years or older living in Ngoma District who presented themselves at the health facilities with signs and symptoms of malaria, and who had been requested to provide a blood smear for malaria diagnosis. Patients who were unable to provide consent or the assent form, those not living in the Ngoma district, and those from detention centers were excluded from the study. Sampling was conveniently done until we reached the expected number of study participants at each site. The total sample size was 420 participants which were equally distributed across all study sites. The systematic random sampling method was used to find study sample and the calculations based on the malaria data in the period of one year before. This was in regard to patients who were presenting with malaria symptoms to whom a malaria test was done.

Study variables

The dependent variable was the malaria test results; and the independent variables comprised the following: gender, age, marital status, education level, occupation, socio-economic status "ubudehe" categorization, owning health insurance, notion of travelling, insecticide treated net (ITN) ownership, knowledge of malaria prevention methods, sleeping under ITN the previous night, sector of residence, and distance from breeding sites.

Data collection

Data collection was done from November to December 2018, data was collected using structured questionnaires with questions on socio-demographic characteristics, socio-economic, environmental factors, behaviour, and knowledge factors about malaria. Independent variables included gender, age, marital status, education level, occupation, wealth quintile (locally named ubudehe category where the people with lowest income are in ubudehe category 1, second in ubudehe category 2, middle in ubudehe category 3 and the highest income in ubudehe category 4), owning health insurance, notion of travelling, Insecticide Treated Nets (ITN) ownership, sleeping under an ITN, knowledge of malaria prevention methods, and lastly the sector of residence. The dependent variable of interest is the participant's malaria results. Data were collected from participants by use of close ended questions and recording blood smears results from laboratory logbook. Variables were identified according to what have been documented in other studies that can expose the victim to Malaria.[19,20] The questionnaire was developed based on those risk factors, and a pilot study was conducted to test data collection tool. The informed consent and/or assent form were obtained from the participants prior to data collection. The trained laboratory staff administered the questionnaire after malaria blood collection by a finger prick. The experienced laboratory technicians collected, stained, and analysed the blood smear for malaria parasites microscopically. Fresh Giemsa 10% was used for blood smear staining. Microscopic examination of blood smear using high power field magnification was done for malaria parasites identification with 100x oil immersion objective. Among the slides, 10% were rechecked by the expert microscopist as certified by WHO.

Statistical analysis

Microsoft Excel was used to gather data collected from all sites and the analysis was done using STATA version 13.0. The univariate analysis was done to characterize the study participants and the analysis output was displayed in tables. The bivariate analysis was done to have an idea on the odds which might be associated with the outcome where the p-value lesser or equal to 0.05 was considered. Then, multivariable logistic regression was conducted for significant variables based on adjusted Odds Ratio to determine the statistically significant association between independent and dependent variables. The results after the analysis was displayed through tables. The univariate data such as socio-demographic variables were presented using a frequency distribution. The confidence interval in this study was 95% with the margin error of 5%.

Ethical consideration

All methods of this work were done through the respect of Helsinki Declaration's standards. [21] Before processing for data collection, there was a review of the research proposal by the Institutional Review Board of the University of Rwanda- College of Medicine and Health Sciences (UR- CMHS) and authorisation through the clearance-No303/CMHS IRB/2018. Permission was also obtained from Kibungo Referral Hospital Local Ethical Committee that informed the administration of health facilities where the study was to be undertaken. Written informed consent or an assent form was obtained from each participant and confidentiality was ensured.

Results

Characteristics of the study participants

In total, 420 people ages five years or older participated in the study. The females were 255 (61%) and males 165 (39%). The largest group was that of people aged 35 or older which accounted for 151 (35.9%) participants. Regarding socio-economic status, the most frequent category (n = 199, 47.38%) was Ubudehe category 2. A high number of participants (n = 418, 99.52%) had health insurance and (n = 324, 77.14%) had at least one mosquito treated nets. More than a half of participants, 282 (67.14%) used a mosquito net the day preceding the interview while 138 (32.8%) didn't and most of them, 408 (97.145%) were aware that being bitten by a mosquito was likely to lead to malaria. The majority (417, 99.3%) were aware about the malaria prevention methods, while 207 (49.29%) lived at less than 1 km from a mosquitoes breeding site. The number of non-smoothed houses were 118 (28.1%) and only 1 (0.24%) reported having a house with rudimentary materials. More than half (254, 60.48%) of the participants reported having a house with a mosquito gauze on the windows. Among the study participants, 257 (61.2%) had malaria parasitaemia confirmed microscopically in their blood sample. (Table 1).

Table 1. Demographic, Socio-economic, behaviour characteristics

Variables	n	%
Demographic factors		
Age (years)		
5-14 years	125	29.76
15-24 years	40	9.52
25-34 years	104	24.76
≥35 years	151	35.95
Marital status		
Married	221	52.62
Not married	199	47.38
Education level		
None	69	16.43
Primary	252	60.00
Secondary and above	99	23.57
Occupation		
Employed	11	2.62
Not employed or farmer	409	97.38
Socio-economic factors		
Ubudehe categorization		
Category 1	71	16.90
Category 2	199	47.38
Category 3	150	35.71
Owning health insurance		
No	2	0.48
Yes	418	99.52
Notion of travelling		
No	411	97.86
Yes	9	2.14
ITN ownership		
No	96	22.86
Yes	324	77.14

Association between independent variables and malaria positivity

Bivariate logistic regression for demographic, socioeconomic, behaviour, knowledge and environment factors showed that male gender (p = 0.014); age group 15-24 years (p =0.007), age group 25-34 years (p = 0.006); age group of 35 years and above (p = 0.002), living in the Mutenderi sector (p = 0.023) and Ubudehe category 3 (p = 0.014) had statistically significant association with the malaria positivity (Table 2 and Table 3).

Table 2. Bivariate analysis of demographic, socio-economic, behaviour and knowledge variables and malaria positivity

Variables	n (%)	OR (unadjusted)	95% CI		p-value
Gender					
Female	144 (56.47)	Ref			
Male	113 (68.48)	0.59	0.39	0.90	0.014*
Age group					
5-14 years	34 (85.00)	Ref			
15-24 years	63 (60.58)	3.68	1.42	9.56	0.007*
25-34 years	75 (60.00)	3.77	1.47	9.65	0.006*
≥35 years	85 (56.29)	4.4	1.74	11.10	0.002*
Ubudehe category					
Category 1	35 (49.30)	Ref			
Category 2	122(61.31)	0.63	0.35	1.05	0.079
Category 3	100(66.67)	0.48	0.27	0.86	0.014*
ITN ownership					
No	62 (64.58)	Ref			
Yes	195(60.19)	1.20	0.75	1.93	0.438
Sleeping under an ITN last night					
No	86 (62.32)	Ref			
Yes	171(60.64)	1.07	0.70	1.63	0.740
Knowledge of prevention					
No	1 (33.33)	Ref			
Yes	256(61.39)	0.31	0.02	3.49	0.346

*Statistically significant at p<0.05

Table 3. Bivariate analysis of environmental factors in association with malaria positivity

Variables	n (%)	OR (unadjusted)	95% CI		p-value
Residence (sector)					
Gashanda	4 (50.00)	Ref			
Jarama	26 (78.79)	0.26	0.05	1.35	0.112
Karembo	1 (33.33)	2.00	0.12	31.97	0.624
Kazo	7 (46.67)	1.14	0.20	6.36	0.879
Kibungo	19 (70.37)	0.42	0.08	2.11	0.293
Mugesera	17(51.52)	0.94	0.20	4.41	0.939
Murama	8 (47.06)	1.12	0.20	6.04	0.891
Mutenderi	30 (88.24)	0.13	0.02	0.75	**0.023***
Remera	30 (73.17)	0.36	0.07	1.72	0.204
Rukira	25 (52.08)	0.92	0.20	4.11	0.913
Rukumberi	25 (69.44)	0.44	0.09	2.08	0.301
Rurenge	17 (45.95)	1.17	0.25	5.42	0.835
Sake	26 (76.47)	0.30	0.06	1.51	0.148
Zaza	22 (40.74)	1.45	0.32	6.44	0.622
Distance from breeding sites					
Less than 1 km	103 (59.20)	Ref			
1 to 4 km	114 (64.77)	0.78	0.51	1.21	0.283
Equal to 5 km or more	40 (57.14)	1.08	0.62	1.90	0.768

*Statistically significant at p < 0.05

Multivariable results

After the multivariable analysis, we saw that malaria positivity among participants was associated with age of 15 years and older as well as those living in Mutenderi Sector (Table 4).

Table 4. Multivariable analysis for association with malaria positivity (N=420)

Variables	AOR	95% CI		p-value
Gender				
Female	Ref			
Male	0.65	0.41	1.02	0.061
Age				
5-14 years	Ref			
15-24 years	3.17	1.12	8.95	**0.029***
25-34 years	3.57	1.28	9.92	**0.014***
>=35 years	3.66	1.33	10.02	**0.012***
Ubudehe Category				
Category 1	Ref			
Category 2	0.59	0.32	1.10	0.101
Category 3	0.63	0.32	1.26	0.196
Residence (sector)				
Gashanda	Ref			
Jarama	0.30	0.05	1.62	0.163
Karembo	1.46	0.08	24.31	0.791
Kazo	1.27	0.21	7.53	0.787
Kibungo	0.43	0.08	2.27	0.325
Mugesera	0.83	0.17	4.03	0.820
Murama	1.01	0.18	5.68	0.990
Mutenderi	3.15	1.22	3.90	**0.038***
Remera	0.35	0.07	1.75	0.206
Rukira	1.00	0.21	4.63	0.993
Rukumberi	0.34	0.06	1.70	0.191
Rurenge	1.06	0.22	5.03	0.939
Sake	0.33	0.06	1.71	0.189
Zaza	1.40	0.30	6.46	0.665

*Statistically significant at $p < 0.05$

Discussion

The study outcomes highlight information relating to the prevalence of malaria parasitaemia and its associated factors among Ngoma district residents five years and older, with malaria signs and symptoms. In the current study, the prevalence of malaria among people with malaria signs and symptoms was 61.2%.

When examining associations between socio-demographic risk factors and malaria, the age of 15 and above was associated with malaria. This finding is similar to that of study done in Ethiopia in 2018 by Tadesse et al where participants between the ages of 16-24 years, 25-34 years and 35-44 years as well, were associated with malaria .[22] This similarity may be due to the fact that older people in these age groups are involved in farming and fishing, which are likely to expose them to mosquito bites. This is similar to the findings for the study done in Northwest Ethiopia by Aschale where both studies were conducted in an environment with a big number of lakes which are considered as mosquito breeding sites. [23] Mutenderi sector has a high volume of malaria breeding sites which contributed to the high number of malaria positive cases in the area compared to other sectors in the study area.

Participants characterised as being in the lower socioeconomic status Ubudehe category were less likely to be associated with malaria and this was in contradiction with the study done in Kenya in 2018 where a higher prevalence was reported among the people in lower socio-economic compared to other socio-economic groups. [24] This difference may be due to the fact that Rwanda assists people in low-income category through the regular distribution of mosquito net and the implementation of Malaria Community Based Management (MCBM). The study findings agree with the study done by Ayalew et al in Ethiopia,[25] and the study done by Godpower C Michael et al (2017) in Nigeria Tertiary Hospital.[30] With regard to malaria prevention, our study findings do not corroborate what was found by Rupashree et al in the study conducted in Nigeria in which most participants did not have enough sensitization on malaria prevention.[26] This difference may be due to the difference in approach used to sensitize people on malaria prevention in these two study areas.

The study found a prevalence of malaria of 61.2% among the study respondents who had consulted the health facilities in the study area from November-December 2018. Our findings in terms of prevalence were almost the same as that found among people consulting at Murtala Muhammed specialist hospital in Nigeria which was 64.9%. However, the prevalence found by our study does not corroborate the findings of Tadesse et al in their 2018 study conducted in Ethiopia where they found the prevalence of 25%.[8,27,22] The different prevalence found in these two studies can be attributed to the fact that the Ethiopian study area used Indoor Residual Spraying (IRS) for vector control, while in our study site IRS was not yet implemented during the study period. On the other hand, the prevalence in our study corroborate that of 60% found in Kenya by Rachel et al in 2018. [15]

Living around stagnant water was not significantly associated with malaria in our study area. This finding contrasted with that of Eshetu et al in their study carried out in Southern Ethiopia.[28] The difference could be explained by the fact that in our study participants living around the stagnant water were few (n= 4, 1.5%) compared to the study done in Southern Ethiopia (n=42, 12%). Our study found higher prevalence of malaria infection (61.2%) which was in contrast with the study done in Kisumu sub-county of Kenya territory in 2015 (28%). These study findings difference could be attributed to the difference in study population where our study recruited only participants with current malaria symptoms presented to the hospital while in the study carried out in Kisumu county recruited asymptomatic participants from their home.[29] It also reported increased age as the main independent predictor of malaria infection, which supports the needs for considering the population of five and older in malaria prevention measures.

Public health implications

The study findings were discussed with authorities in the study area as one of the advocacy mechanisms. As of now, the IRS has been initiated in the study area and this will most likely effectively reduce the malaria incidence and prevalence.

Limitations

Our study was of a cross-sectional designed, hence some long-term variations due to various factors might not have been captured.

Conclusion

The malaria prevalence in Ngoma District was found to be (61.2%) among febrile patients. This study demonstrates the importance of emphasis on malaria control and prevention among the population aged of 15 years and older. It requires multidisciplinary interventions in Mutenderi Sector to maximaze the implementation of Malaria control and preventive measures given that it has been found that to live there may be associated with Malaria occurrence. To work on this, health sector with all stakeholders including local leaders have to understand the burden of Malaria in Mutenderi Sector. This can be accomplished by improving designs in planning and interventions strategies for reducing malaria burden in Mutenderi sector, and in particular the Ngoma district in general. Lastly, the high malaria prevalence in the study area highlights the need to boost malaria interventions in the area by including the vector control strategies like IRS. The outcomes guide stakeholders about the appropriate interventions that could boost malaria control and prevention in the area.

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Author's contributions

JCN and LN designed the whole study including methods design, data collection and analysis as well as drafting manuscript. JN and FH supported in report drafting, proofreading, and editing of the manuscript. JN has contributed in data interpretation and deeply revised the whole paper for it to be consistent especially in regards to its intellectual content. All authors confirm agreed the submissiom of this manuscript to this journal, are accountable of the work content and are aware of this final version to be submitted and published as well.

Conflict of interest

The authors didn't declare any competition of interest

References

1. WHO. World Health Organization. World Malaria Report 2021. Word Malaria report Geneva: World Health Organization. (2021). Licence: CC. Geneva: *World Health Organization*. 2021;2013–2015.
2. Erbach-Schoenberg EZ, Alegana V, Sorichetta A, Linard C, Lourenço C, Ruktanonchai N. Dynamic denominators: The impact of seasonally varying population numbers on disease incidence estimates. *Popul Heal Metr.* 2016;14(1):1–10.
3. Kalra S, Khandelwal D, Singla R, Aggarwal S, Dutta D. Malaria and diabetes. *J Pak Med Assoc*. 2017;67(5):810–3.
4. Bloom D, Sachs J. Geography, demography, and economic growth in Africa. *Brookings Pap Econ Act.* 1998;(2):207–95.
5. Topazian H, Gumbo A, Puerto-Meredith S, Njiko R, Mwanza A, Kayange M. Asymptomatic Plasmodium falciparum malaria prevalence among adolescents and adults in Malawi, 2015–2016. *Sci Rep*. 2015;10(1):1–11.
6. Head M, Goss S, Gelister Y, Alegana V, Brown R, Clarke S. Global funding trends for malaria research in sub-Saharan Africa: a systematic analysis. *Lancet Glob Heal*. 2017;5(8):e77.
7. WHO. Roll Back Malaria Partnership. Action and investment to defeat malaria 2016-2030. *Geneva : World Health Organization;* 2008.
8. Yegorov S, Galiwango R, Ssemaganda A, Muwanga M, I W, Miiro G. Low prevalence of laboratory-confirmed malaria in clinically diagnosed adult women from the Wakiso district of Uganda. *Malar J.* 2016;15(1):1–8.
9. Jenkins R, Omollo R, Ongecha M, Sifuna P, Othieno C, Ongeri L. Prevalence of malaria parasites in adults and its determinants in malaria endemic area of Kisumu County, Kenya. *Malar J.* 2015;14(1):1–6.
10. Mvumbi D, Bobanga T, Melin P, Mol P De, Kayembe J, Situakibanza H. High Prevalence of Plasmodium falciparum Infection in Asymptomatic Individuals from the Democratic Republic of the Congo. *Malar Res Treat*. 2016;2016.
11. Winskill P, Rowland M, Mtove G, Malima R, Kirby M. Malaria risk factors in north-east Tanzania. *Malar J*. 2011;10:1–7.
12. Nzayirambaho M, Bizimana J, Freund R, Millet P, Merrien F, Potel G. Impact of home-based management of malaria combined with other community-based interventions: What do we learn from Rwanda? *Pan Afr Med J*. 2013;14.
13. Karema C, Aregawi M, Rukundo A, Kabayiza A, Mulindahabi M, Fall I. Impact of antimalarial interventions on trends in malaria cases, hospital admissions and deaths, 2000-2010, Rwanda. *Am J Trop Med Hyg*. 2012;4.
14. Ministry of Health (MoH). Rwanda: Health sector annual report July 2013-June 2014. *Ministry of Health*. 2014;(July 2013):12–40.

15. Morrow M, Sarriot E, Nelson A, Sayinzoga F, Mukamana B, Kayitare E. Applying the community health worker coverage and capacity tool for time-use modeling for program planning in Rwanda and zanzibar. *Glob Heal Sci Pr*. 2021;16:S65–78.
16. Karema C, Wen S, Sidibe A, Smith JL, Gosling R, Hakizimana E, et al. History of malaria control in Rwanda: Implications for future elimination in Rwanda and other malaria-endemic countries. *Malar J*. 2020;19(1):1–12.
17. U.S. President's Malaria Initiative. President's Malaria Initiative - Rwanda Malaria Operational Plan FY 2018. 2018.
18. NISR. EICV3 DISTRICT PROFILE East - Ngoma . *National Institute of Statistics/ Rwanda*. 2012.
19. Habyarimana F, Ramroop S. Prevalence and risk factors associated with malaria among children aged six months to 14 years old in rwanda: Evidence from 2017 rwanda malaria indicator survey. *Int J Env Res Public Heal*. 2020;17(21):1–13.
20. Tesfahunegn A, Berhe G, Gebregziabher E. Risk factors associated with malaria outbreak in Laelay Adyabo district northern Ethiopia, 2017: Case-control study design. *BMC Public Health*. 2019;19(1):1–7.
21. Carlson R V, Boyd KM, Webb DJ. The revision of the Declaration of Helsinki: past, present and future. *Br J Clin Pharmacol*. 2004;57(6):695–713.
22. Tadesse F, Fogarty A, Deressa W. Prevalence and associated risk factors of malaria among adults in East Shewa Zone of Oromia Regional State, Ethiopia: A cross-sectional study. *BMC Public Health*. 2017;18(1):1–8.
23. Aschale Y, Mengist A, Bitew A, Kassie B, Talie A. Prevalence of malaria and associated risk factors among asymptomatic migrant laborers in West Armachiho District, Northwest Ethiopia. *Res Mep Trop Med*. 2018;9:95–101.
24. Were V, Buff A, Desai M, Kariuki S, Samuels A, Kuile F Ter. Socioeconomic health inequality in malaria indicators in rural western Kenya: Evidence from a household malaria survey on burden and care-seeking behaviour. *Malar J*. 2018;17(1):1–10.
25. Astatkie A. Knowledge and practice of malaria prevention methods among residents of Arba Minch Town and Arba Minch Zuria District, Southern Ethiopia. *Ethiop J Heal Sci*. 2011;20(3).
26. Singh S, Ebere U, Singh R, Musa J. Knowledge, attitude and practices on malaria among the rural communities in Aliero, Northern Nigeria. *J Fam Med Prim Care*. 2014;3(1):39.
27. Oladele O, Onuoha S, Hamafyelto H, Omisope O, Fauziyya A, Akindigh M. Prevalence of malaria infection among patients attending Murtala Muhammed specialist hospital Kano, Nigeria. *African J Clin Exp Microbiol*. 2019;19(3):214–20.
28. Ayele EB. Prevalence of Malaria and Associated Factors in Dilla Town and the Surrounding Rural Areas, Gedeo Zone, Southern Ethiopia. *J Bacteriol Parasitol*. 2015;06(05).
29. Jenkins R, Omollo R, Ongecha M, Sifuna P, Othieno C, Ongeri L, et al. Prevalence of malaria parasites in adults and its determinants in malaria endemic area of Kisumu County, Kenya. *Malar J. BioMed Central*; 2015;14:1–6.
30. Michael GC, Aliyu I, Grema BA. Knowledge of malaria and adherence to its preventive measures among adults
31. attending out-patient clinics of a Nigerian tertiary hospital: Has anything changed?. Afr J Med Health Sci 2017;16:43-51. DOI: 10.4103/ajmhs.ajmhs_81_16