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Asymptomatic malaria in selected rural health facilities in Vihiga County, Western Kenya

John Khamala Ongonda, Cyrus Ayieko, Elly Ochieng Munde, Stephen Miheso

Department of Zoology, School of Physical and Biological Sciences, Maseno University, Kisumu, Kenya

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ABSTRACT

Aims: Malaria is still a devastating health challenge in the world. In 2022, Africa accounted for 93.6% of all malaria cases with 95.4% deaths globally. Kenya recorded about 3.5 million new malaria cases with a mortality of 12,011 deaths while Vihiga County had a prevalence of 20% for all symptomatic outpatients. Asymptomatic malaria infection in Kenya was reported as 42% and 10% from two malaria endemic areas. Asymptomatic patients never visit health facilities for treatment but remain Plasmodium falciparum reservoirs in the community. This study assessed the occurrence of asymptomatic malaria around five rural health facilities in a malaria endemic Vihiga County, Western Kenya.

Methods: This was a cross-sectional survey targeting 336 participants and running between April 2022 and March 2023. CareStart malaria HRP2 (Pf) was used for sample diagnosis as per manufacturer's instructions. Demographic and other laboratory parameters of study participants were taken.

Results: Chi-square was used to analyse this data. Average percentage prevalence for asymptomatic malaria was 8.3%; (95% CI; 5.3%-10.8%, $p<0.05$). Age category of below five years had a prevalence of 2.5% (95% CI: 0.6%-9.5%, $p>0.05$), between five and seventeen years was 10.6% (95% CI: 5.8%-15.2%, $p<0.05$) and above seventeen years was 9,6% (95% CI: 4.7%-14.6%, $p<0.05$). Females had a prevalence of 9.6% (95% CI: 5.5%-13.7%, $p<0.05$) while males had 6.9% (95% CI: 3.5%-11.0%, $p<0.05$). High quarterly rainfall of 249.7 mm had 12.2% prevalence while low rainfall of 12 mm had 1.2% prevalence of asymptomatic malaria respectively

Conclusion: This study demonstrated the presence of asymptomatic malaria participants in Vihiga County, Western Kenya. There were more asymptomatic cases during rainy than dry seasons. This study underscores the need for continued surveillance and treatment of the malaria asymptomatic cases to reduce its spread.

Keywords: Malaria, asymptomatic malaria, mRDT, Pfhrp2/3

INTRODUCTION

Malaria is a devastating health challenge in the world. It is caused by five species of the malaria causing parasites in human beings namely *Plasmodium vivax, Plasmodium malariae, Plasmodium ovale, Plasmodium knowlesi* and *Plasmodium falciparum*.[1,2] The most prevalent of the species is the *Plasmodium falciparum*.[3] Out of 234 million malaria cases in the world 70% were recorded in Africa.[4] In Kenya, there have been efforts made to reduce the spread of malaria however; it still records 6.7 million cases annually with 4000 deaths most of who are children.[3,5] In 2022, Vihiga County which is found in a malaria endemic Lake Victoria basin, recorded a malaria prevalence of 20% of all outpatient to the health facilities.[6] Asymptomatic malaria refers to a condition where an individual is *infected Plasmodium falciparum* but does not show any symptoms of malaria, such as fever, chills, headache, or fatigue. Its infection in Kenya has been reported as 42% and 10% from two malaria endemic areas respectively. Since asymptomatic patients do not freely come for treatment, they are never treated therefore, they remain as parasite reservoirs in the community which is a set-back to malaria eradication strategies.[7,8]

Malaria does manifest itself with symptoms like fever, headache, hypoglycaemia, respiratory distress, nausea, jaundice among others which can be confirmed by diagnostic tests, however, it may fail to show any of these signs but test positive on diagnosis hence said to be asymptomatic.[8,9] Asymptomatic malaria refers to the presence of asexual parasites in the peripheral blood which can be confirmed by diagnosis.[9,10] Due to high mortality caused by malaria, WHO has recommended rapid diagnostic tests (RDTs) targeting the *Plasmodium falciparum* to mitigate against deaths caused by the parasites.[2,11,12] Most of the malaria prevalence reports from various studies may be less accurate as they rely on data from hospital visits by symptomatic patients. Malaria symptomatic cases are not documented and consequently are not planned

Corresponding Author: John Khamala Ongonda, Ongonda.khamala@gmail.com

for. Unfortunately, such like patients become malaria parasite reservoirs since they do not show any malaria signs but become sources of transmission between infection cycles in the community.[10,11]

There are three methods that are used in malaria diagnosis namely microscopy, molecular method by use of polymerase chain reaction (PCR) and the rapid diagnostic test (RDT).[2,7,12] In Vihiga County, the use mRDT to detect *Plasmodium falciparum*-specific rich histdine rich proteins (Pfhrp 2/3) is broadly used for diagnosis, especially in malaria surveillance studies.[12] Research has shown that Pfhrp2/3 is not necessarily an essential gene for the growth of the parasite but it's a bio-marker antigen for the presence of *Plasmodium falciparum* in hosts' blood circulation.[2,7,12]

The prevalence of asymptomatic malaria varies with different areas of study in world. In Uganda, the prevalence of asymptomatic cases reported was 34.7% while Tanzania recorded an average prevalence of 37.3%.[7,13,14,15] In Ghana, asymptomatic cases were recorded at 8% while Webuye and Ajigo areas in Western part of Kenya had an asymptomatic percentage prevalence of 10% and 42% recorded respectively.[7,16] On an extreme end, there was a site in Kenya called Kapsisywa which had only two (2) cases and Kipsamoite which did not record any asymptomatic case.[7,16,17]

To control the spread of malaria, World Health Organization (WHO) has recommended testing, treating and tracking of the disease as a disease management protocol.[18] If Malaria is diagnosed early and effectively treated, it reduces the spread of the parasite in the community. However, malaria control is faced with many challenges of improper diagnosis, inadequate resource allocation, inexperienced technical personnel, poor tracking of cases and lack of clinical confidence in diagnostics which is manifested in the lack of accuracy some test-results.[19] Other determinants that control the dynamics of spread of malaria and accurate diagnosis includes spatio-temporal distribution of the malaria cases, intensity of infection, method of diagnosis and the presence of asymptomatic malaria cases.[7,20,21] Studies on malaria prevalence in Vihiga County have concentrated on suspected malaria visits to the health facilities and attention has been on children under five years and pregnant mothers; the two populations that are considered most vulnerable to malaria infection.[8,10,17,22] No study has reported on asymptomatic status in this region hence this study assessed the prevalence of asymptomatic malaria cases around the selected health facilities in Vihga County, Western Kenya.

METHODS

Ethical Approval

This study was approved by the Maseno University Scientific Ethics Committee (Date: 06.06.2022, Decision No: MUSERC/01047/22) and The National Commission of Science, Technology and Innovation, in Kenya (Date: 01.07.2022, Decision No: NACOSTI/P/22/18417) which provided the research permit. The Vihiga County Commissioner, Vihiga County Director of Education and the County government of Vihiga also approved data collection in the County. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Study Design

This was a community based cross- sectional survey carried out in the catchment area of five rural health facilities between April 2022 and March 2023 among the 336 in Vihiga County Western Kenya. Apparently, it targeted healthy participants of all ages recruited by way of consenting and signing a questionnaire and it was designed to run through dry and wet period through the twelve months. The p-value for the significant difference between the rainy and non-rain will be computed. Vihiga County has the highest population density in Kenya of 1,094 persons per square kilometre, way above the national average of 66 persons per square kilometre.[9] The neighbouring Counties of Nandi, Kakamega, Siaya and Kisumu have high transmission rate, especially, during the long rainy season.[22,23] Entomological inoculation rate (EIR) varies with specific location from 6.000-0.145 infective bites/person/night.[24,25] In Vihiga County, malaria is endemic and with mosquito bites of over 300 per month. Malaria is experienced throughout the year with peaks of transmission both during long rains (april, may and july) and short rains (october, november and part of december). Most people in this County live in the villages which are densely populated.[6,23] Blood samples were collected from consenting patients using a finger-prick for Care startTM rapid diagnostic tests. Thick and thin blood smears were prepared and Giemsa stained for microscopy. Dried blood spots on whatman filter paper for use during molecular analysis by polymerase chain reaction were also prepared.[25,26]

The Study Area

Vihiga is located $0^0$17'N, $34^0$74'E, and receives rainfall ranging between 1800mm-2000mm with distinct long and short rainy seasons. The mean temperature is 23^0C, ranging between 14^0-32^0C. The altitude varies between 1300m and 1500m above sea level.[6] Vihiga County has five sub counties and the study purposefully sampled one rural (furthest from the main sub county hospitals) health facility per Sub County. These health facilities mainly relied on mRDTs as the main malaria diagnostic method. Microscopy and PCR methods are not in use in these facilities for lack of infrastructure (electricity, Reagents, equipment) and well-trained staff for reading and interpreting the results.[26-28] These health facilities were Ekwanda health centre in Luanda Sub County, Musunguti Dispensary in Vihiga Sub County, Bugina health centre in Sabatia Sub County, Kaptis Dispensary in Hamisi Sub County and Esiarambatsi Health centre in Emuhaya Sub County.

Sample Size Determination

The sample size was determined by Charan J. and Biswas T. (2013) formular:[30]

$$n = \frac{Z^2 p(1-p)}{d^2}$$

Where; n is the expected sample population, Z is the score of the confidence level (95%)=1.96, p is expected population at a

prevalence of 32.4%[29] and d is the margin of error=5% (0.05). This formula yielded a sample population of 337 of which, one dropped off from the study giving final sample population of 336.

Inclusion and Exclusion Criteria

In this study, there was no restriction on age limit and were stratified in three categories of 1 (below five years), 2 (between 5 and 17 years) and 3 (more than seventeen years). All participants or their guardians (for the under age) had the fill a consent form for enrolment into this study. They were also allowed freedom to withdraw from the study whenever they deemed fit without any prejudice of missing out on treatment if they were mRDT positive for malaria. Other participants that did not consent to the study and those that had malaria symptoms were excluded from the study.

Blood Collection and Processing

Trained phlebotomists collected finger prick blood samples from volunteers from the sampled rural hospitals of the five sub-counties of Vihiga County. The finger prick produced about 0.5mL of blood from each volunteer. The study used an immunochromatographic rapid diagnostic test that targets the Pfhrp2/3 protein.[26,28,31] The testing process involved putting blood in the capillary tube which was used to put a drop of blood in a sample well from which the specimen migrates through the nitrocellulose membrane by capillarity. Two drops of the buffer assay were added to the buffer well. The test pad is coated with monoclonal antibodies specific for the Pfhrp2/3 malaria parasite antigens. The test results showed either presence or absence of the colour bands as compared to the control colour band that should and must show for accurate test interpretation. The results were read after 20 minutes.[12] The sensitivity of the RDT (for true positive results) is placed at 98% and the specificity (ability to detect true negative) is 97.5%. The reliability and validity of the test mRDT outcome was ensured by following the methods manual for product testing of mRDT, version seven, 2018.[11] The people who turned out to be positive (even if they did not show any symptoms) for the Plasmodium falciparum parasites were subjected to treatment with artemether lumefantrine (Coartem) anti-malaria drugs[18]. Whole blood was preserved by spotting the dry blood spot (DBS) paper for future processing and analysis as recommended by WHO.[18]

Instruments of Data Collection

The interviews were conducted either in English, Kiswahili or local language (Luhya) for inclusivity. Interpretation as positive mRDT outcome used the WHO guidelines for both faint and clear thick visible bands.[18] The clinic form was designed to capture gender, age, location (area of stay), the malaria history and symptoms if any. The participants diagnosed for malaria around the five health facilities were later categorised in to two tables segregated by sex and age as shown in **Table 1, 2**. The age brackets (x) applied in this section are: 1 which is x≤5 years, 2 is 5<x≤17 years and 3 is x>17 years.

Table 1. Asymptomatic mRDT positive cases within Vihiga County based on age categories and sex

The health facilities	Infection status		Age categories			Sex	
	Positive	Negative	(1) x≤5 years	(2) 5 years <x≤17 years	(3) x>17 years	Male	Female
Ekwanda (n=49)	4	45	0/15	3/23	1/11	1/22	3/27
Esiarambatsi (n=178)	13	165	2/45	6/78	5/55	6/86	7/92
Bugina (n=46)	4	42	0/7	1/20	3/19	2/25	2/21
Musumguti (n=31)	3	28	0/7	2/15	1/9	0/13	3/18
Kaptis (n=32)	4	28	0/5	3/6	1/21	3/13	3/19
Totals	28/336	308	2/79	15/142	11/115	11/159	17/177
Asymptomatic Prevalence	8.30%		2.50%	10.6%	9.60%	6.90%	9.60%
95% Confidence interval	5.3%-10.8%		0.6%-9.5%	5.8%-15.2%	4.7%-14.6%	3.5%-11.0%	5.5%-13.7%
p-value (≤0.05)	<0.001		0.787	<0.001	<0.001	<0.001	<0.001

Table 2. Average monthly Rainfall against positive asymptomatic malaria rapid diagnostic test participants in Vihiga County, Western Kenya

Year	2021									2022		
Months	Apr	May	Jun	Jul	Sep	Aug	Oct	Nov	Dec	Jan	Feb	Mar
Monthly Rainfall (mm)	312	320	177	132	259	360	180	198	247	0.8	0.2	35
n=336	39	37	26	29	32	22	19	24	38	19	24	27
Positive Asymptomatic malaria (28)	6	5	2	2	3	4	1	1	3	0	0	1
Percentage (%) prevalence	15.4	13.5	7.7	6.9	9.4	9.1	5.3	4.2	7.9	0	0	3.7
Average quarterly Rainfall (mm)	249.7			250.3			208.3			12		
Average quarterly asymptomatic malaria % ages (Q)	Q2=12.2%			Q3=8.5%			Q4=5.8%			Q1=1.2%		

Statistical Analysis

A total of 336 participants consented for enrolment and were subjected to Pfhrp2/3 mRDT. The positive cases were identified and categorised as per their ages and sex which were critical parameters for this study. Data was analysed using frequency counts and percentages with the help of STATA package version 18.0. The findings were presented in tables and discussed. Both descriptive and inferential statistics were used in the analysis. For inferential statistics, Chi-square test of associations was used at a $p<0.05$ statistical significant, which indicated 95% confidence interval. Positive asymptomatic mRDT cases were analysed by age and sex to establish any associations between the parameters and the mRDT outcome. The positive cases were counted recorded, analysed and presented in **Table 1**. Moreover, confidence intervals were calculated to show the percentage range within which the cases would fall from all expected cases at 95% confidence interval.

RESULTS

In a duration of twelve (12) months spanning two (2) years divided in 4 quarters (of 2nd, 3rd and 4th quarters in 2021 and 1st quarter for 2022), community Health workers went round within catchment areas of the five health facilities and engaged the public on malaria transmission and testing. They recruited the volunteers who accepted to be part of the study. The participants were recruited on signing the informed consent form. Their ages and gender were critical parameters for inclusion. In this study, a *Plasmodium falciparum* histidine rich protein 2/3 (Pfhrp2/3) test was performed as the results were availed to the participants positive cases were commenced on malaria treatment.

Asymptomatic mRDT Positive Cases within Vihiga County Based on Age Categories and Sex

The age categories stratification of the asymptomatic malaria cases within the study area of the five health facilities are illustrated in **Table 1**.

n; represents the total number of participants in each health facility. Positive were asymptomatic participants who tested positive using mRDT. (1); Age below 5 years. (2): Ages between 5 years and 17 years. (3): Ages above 17 years. For the age categories, the numerators were the test outcome while the denominators were the samples diagnosed from that age group. M represents male and F female' the p-values were considered significant at $p\leq0.05$. Values in bold are significant p-values at a cut off of $p\leq0.05$.

Ekwanda health centre had a total of forty nine (49) participants diagnosed for malaria using mRDT. Four (4) out of forty nine (49) tested positive. There was no asymptomatic malaria for the age bracket of below 5 years while there were three (3) and one (1), positive asymptomatic malaria among the age categories between 5 and 17 years and above seventeen (17) years, respectively. Out of the four positive asymptomatic participants at Ekwanda health centre, one (1) was a male while three (3) were females, Esiarambatsi health centre had a total of one hundred and seventy eight (178) participants out of which thirteen (13) tested positive for malaria using mRDT. Of the thirteen (13), two (2) out of forty five (45) participants diagnosed from the first age category of below five (5) years were positive for malaria.,From the second category of between five (5) and Seventeen (17) years, six (6) were out of seventy eitght (78) diagnosed in that category were positive. The final age category of more than seventeen years had five (5) out of fifty five (58) being positive for malaria. Esiarambatsi had six (6) out of eighty six (86) males and seven (7) out of Ninety two (92) femaleas positive for malaria when diagnosed using mRDT. Bugina health centre had a total of forty six (46) participants out of which four (4) tested positive for malaria using mRDT. None (0) out of seven (7) participants from the first age category of below five (5) years was positive for malaria. The second category of between five (5) and Seventeen (17) years had only one (1) out of twenty (20) being positive for malaria. The final age category of more than seventeen years had three (3) out of nineteen (19) being positive for malaria. Bugina had two (2) out of twenty five (25) males and two (2) out of twenty one (21) females being positive for malaria when diagnosed using mRDT. Musunguti dispensary had a total of thirty one (31) participants out of which three (3) tested positive for malaria using mRDT. None (0) out of seven (7) participants from the first age category of below five (5) years was positive for malaria. The second category of between five (5) and Seventeen (17) years had two (2) out of fifteen (15) being positive for malaria. The final age category of more than seventeen years had only one (1) out of nine (9) being positive for malaria. Musunguti had none out of thirteen (13) males and three (3) out of eighteen (18) females being positive for malaria when diagnosed using mRDT Kaptis dispensary had a total of thirty two (32) participants out of which four (4) tested positive for malaria using mRDT. None (0) out of five (5) participants from the first age category of below five (5) years was positive for malaria. The second category of between five (5) and Seventeen (17) years had three (3) out of six (6) being positive for malaria. The final age category of more than seventeen years had only one (1) out of twenty one (21) being positive for malaria. Musunguti had three (3) out of thirteen (13) males and three (3) out of nineteen (19) females being positive for malaria when diagnosed using mRDT.

In **Table 1**, the asymptomatic malaria infection status from the three hundred and thirty six (336) participants was twenty eight (28). a prevalence of 8.3% (95% CI. 5.3%-10.8%, $p<0.05$). The first age category of 1 (below five years) had two (2) asymptomatic malaria positive out of seventy nine (79) participants. This was a prevalence of 2.5% (95% CI. 0.6%-9.5%. $p>0.05$). The second category of 2 (between five and seventeen years) had fifteen (15) asymptomatic malaria positive out of one hundred and forty two (142) participants. This was a prevalence of 10.6% (95% CI. 5.8%-15.2%. $p<0.05$). The last category of 3 (over seventeen years) had eleven (11) asymptomatic malaria positive out of one hundred and fifteen (115) participants, a prevalence of 9.6% (95% CI. 4.7%b-b14.6%. $p<0.05$). Out of the three hundred and thirty six (336) participants with twenty eight (28) asymptomatic malaria positive; the number of male participants was one hundred and fifty nine (159) from which eleven (11) were malaria positive, a prevalence of 6.9% (95% CI. 3.5%-11.0%. $p<0.05$). The female participants were one hundred and seventy seven

(177) out of which, seventeen (17) were asymptomatic malaria positive. This was a prevalence of 9.6% (95% CI. 5.5%-13.7%. p<0.05).

The effect of seasonality on the prevalence of asymptomatic malaria in Vihiga County, Western Kenya

Transmission of malaria depends on various human activities and climatic conditions. Rainfall is a key climatic factor that influences breeding patterns of the mosquito vector.

The study ran for twelve months between April 2021 and March 2023, Daily amount of rainfall was recorded and its monthly average computed in mm. n (336) was the total number of participants that were tested using mRDT kit of which twenty eight (28) were found to be asymptomatic malaria positive. Malaria positive participants had been detected in all but two (2) months of january and february. Percentage prevalence was calculated for each of the ten months that reported malaria positive participants. The Average quarterly Rainfall (mm) was assessed alongside average quarterly (Q) percentage prevalence for asymptomatic malaria participants.

The study was designed to run for twelve months between April 2021 and March 2023. Daily amount of rainfall was recorded and was used to compute monthly average in mm as shown in **Table 2**. n (336) was the total number of participants that were subjected to mRDT tests of which 28 were found to be malaria positive. Malaria positive participants had been detected in all but two (2) months of january and february. Percentage prevalence was calculated for the eleven months that reported malaria positive participants. The average quarterly rainfall (in mm) were 249.7, 250.3. 208.3 and 12.0 were assessed alongside average quarterly (Q) prevalence of 12.3%, 8.5%, 5.8% and 1.2% for asymptomatic malaria participants (**Table 2**).

DISCUSSION

Vihiga County is found in a malaria endemic Lake Victoria region of Western part of Kenya with an infection prevalence of between 13%-15% of all outpatients visiting the health facilities. Asymptomatic malaria infection in Kenya has been reported by various studies albeit inconsistencies in prevalence.[7,8] Since these asymptomatic patients are never identified and treated, they become *Plasmodium falciparum* reservoirs in the community hence a hindrance to malaria eradication processes. This study used malaria rapid diagnostic test (mRDT) to assess the occurrence of asymptomatic malaria participants in the catchment areas of the five rural health facilities in Vihiga County, Western Kenya which is a malaria endemic zone. The study established the presence of malaria asymptomatic cases with a prevalence of 8.3% (p<0.05) from the sample population of 336. This prevalence was less than the 42% found in Ajigo and 10% found in Webuye which are two endemic areas to malaria in Kenya. Ghana had previously recorded a prevalence of 8% which was slightly less than the 8.3% found in Vihiga County.[7,17] This value was consistence with the 8% value obtained in Ghana[7] but was less than 19% reported in Nigeria and 34.7% reported in Uganda.[8,10,29]

This study was designed to establish the occurrence and percentage prevalence of malaria asymptomatic participants in Vihiga County. It was informed by variations in values reported for malaria occurrence and prevalence for studies undertaken by different researchers but in the same area. Therefore, malaria prevalence has always been underestimated since some malaria cases which are asymptomatic status are not identified in the community. This is caused by presence of patients that do not show any of the malaria symptoms hence are never identified consequently; they are not part of the plans for malaria treatment and control.[32] Malaria management and control can be effective if there is focus not only on case visits to the health facilities but on asymptomatic people in the community as well.

The dynamics of malaria infection is controlled by many factors which can be broadly categorised as human hosts, the nature of parasite subspecies, the agents of transmission and the geographical influence caused by rainfall and other environmental factors. This study considered demographics of human hosts and the rainfall patterns at the time. It aimed at finding out if the sex and age of an individual can influence the occurrence of asymptomatic malaria cases in the population. The sexes were defined as either male (M) or female (F) and the ages were categorised in three categories of five (5) years and below, between five (5) years and seventeen (17) years (included) and lastly more than seventeen years. This research finding revealed that the two parameters of sex and age have significance influence to occurrence of asymptomatic malaria infections in the populations in Vihiga County as previously reported as 10% in Webuye, Western Kenya.

The age group which had least infections of asymptomatic malaria was that belonging to (1) 'below five years' which recorded two (2) positive subjects out of a total 336 participants (**Table 1**). Their history indicated that they had been exposed to anti-malarial drugs in the recent past prior to random testing. In this category, the prevalence of asymptomatic malaria was not statistically significant (p>0.05). This implied that this category does not have risk of experiencing asymptomatic malaria and can be attributed to various factors that are associated with participants in this age category as reported in other studies.[7,33] They have not developed naturally acquired immunity to malaria yet, which normally results from several entomological bites by the vector causing many inoculations of the parasites; they are immunologically naïve to infections.[34,35] Lack of natural immunity also makes them very vulnerable to parasite exposure with resounding symptoms that are easily detected for treatment and control. The participants in this category frequent antenatal clinics from where they are introduced to the malaria vaccines which has slowed down malaria infection in this population.[32] Sensitization on the adverse effects of malaria coupled up with advocacy for- and the use of long lasting treated mosquito nets has helped in controlling the spread of malaria.[32,36]

There is shift in asymptomatic malaria participants from the under five years to the other age groups reported in this study and it is in consistent with other reports from other studies.[31] The highest prevalence was noted in the middle age bracket of 2 with a value of 10.6%. It represents a big reservoir for asymptomatic malaria parasites. The adult category (ages of above 17 years) had the second highest prevalence

(9.6%) of asymptomatic participants. The two categories of 2 [between five (5) to seventeen (17) years] and 3 [more than seventeen an (17) years] both had a p<0.05. The occurrence of asymptomatic malaria was significant to the two age bracket. These categories of participants have been exposed to very many malaria parasite inoculations brought about by a long period of exposure-time to mosquito bites of the participant.[27] This has made them develop naturally acquired immunity which makes them resistant to the presence of the parasite hence do not present themselves to the health facilities as malaria infected.[10]

Heavy rains and warm temperature increases malaria transmission status since there will be proliferation of the malaria parasite vectors.[11] This, consequently, increased spread of the symptomatic malaria but also showed high prevalence of asymptomatic patients during high rainfall periods as shown in **Table 2**. The high average rainfall experienced in the quarter 2 (249.7 mm) and 3 (250.3) of 2021 was marched with high prevalence of 12.2% and 8.2%. This showed positive relationship between high rainfall and occurrence of asymptomatic malaria cases. High rainfall increases pools of water and hence the breeding sites for the parasite vectors.[37,38]

The prevalence of asymptomatic malaria was 8.3% of which, the prevalence of males was 6.9% (p<0.05) while that of the females was 9.6% (p<0.05). There was significance influence of the sexes to the occurrence of asymptomatic malaria in this region. The females had a higher prevalence of asymptomatic malaria than their male counterpart. This could be attributed to their evening activities of cooking in the open, and other household chores, mostly done outside their houses exposing the m to malaria mosquito vectors.[6] Female were also generally more willingly to participate in the study than their male counterpart.

Stakeholders in health matters have increased efforts in malaria control in the children less than five years of age because of their naive immunity to malaria parasites, which if not abetted, may result to high mortality. The source of danger to the community is the middle age bracket (between 5 and 17 years). They have a high percentage of asymptomatic malaria cases and if they are not identified out through constant surveillance and treatment commenced, they will remain the source of the parasites for the vectors and hence an impediment to malaria management and control strategies. It therefore calls for increased cross-sectional surveys in malaria endemic regions to help point out malaria asymptomatic victims for treatment. This will help eradicate malaria parasites from the less addressed reservoir of asymptomatic individuals.

The malaria management strategy in most health facilities in Vihiga County is testing, treating and tracking of those patients visiting the facilities. Therefore the prevalence reported is based on case visits to the health facilities; rarely does it capture malaria parasite reservoirs in asymptomatic subjects. Since asymptomatic malaria cases help transcend parasite between malaria infection residents. This report, therefore, advises on regular community malaria surveys to target asymptomatic cases and make referrals for treatment and follows ups as a malaria control.

Limitations

- Low parasite density which makes detection by standard methods (microscopy) difficult
- Underrepresentation of some categories of people during sampling for example mobile people were not considered but may also be asymptomatic cases among them
- Testing of people who are not sick may elicit ethical issues and therefore make follow ups sessions difficult
- Lack of information on the actual people who progress from asymptomatic from symptomatic malaria.

CONCLUSION

This study showed an asymptomatic malaria prevalence of 8.3% distributed, albeit not uniformly, between the sexes and throughout the three age categories of young, middle and old age. The middle age category had the highest prevalence of the malaria cases. There were more asymptomatic malaria participants during rainy season as compared to the dry season. This calls for all-inclusive malaria control strategies with reference to age stratification, gender disparity and seasonal changes so that asymptomatic malaria cases are detected and treated off the community.

Recommendations;

- Regular malaria epidemiological surveys targeting asymptomatic populations should be carried out to help manage challenge caused by malaria.
- Large scale studies using highly sensitive diagnostics procedure should be conducted to help flag out asymptomatic cases for treatment and advice on policy direction on malaria management.
- Introduction of free malaria treatment as an incentive to those asymptomatic subjects who voluntarily seek diagnosis for malaria.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was carried out with the permission of the Maseno University Scientific Ethics Committee (Date: 06.06.2022, Decision No: MUSERC/01047/22).

Informed Consent

Written consent was obtained from the patients or Guardians of the under age patients participating in this study.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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