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Prevalence of asymptomatic malaria and risk factors among school-aged children in Kibiti district, Coastal region of Tanzania

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ABSTRACT:

— ***Objective:*** The study aimed to investigate the burden and risk factors for asymptomatic malaria among school-aged children in the Kibiti district, Coastal region of Tanzania.

— ***Subjects and Methods:*** A school-based cross-section study involving 316 school-aged children was conducted from June to July 2021 in the Kibiti district. The venous blood samples were drawn for asymptomatic malaria diagnosis by rapid diagnostic test (CareStart™ Malaria Pf (HRP2) Ag RDT) and microscopy. A structured questionnaire was employed to gather the risk factors for asymptomatic malaria in study participants. Descriptive statistics were used to summarize the individual variables and Chi-square was used to test the association.

— ***Results:*** The prevalence of asymptomatic malaria by rapid diagnostic test and microscopy was 20.3% (95% CI 15.8-25.3) and 17.7% (95% CI 13.6-23.7), respectively. Of the assessed risk factors, there was a statistically significant association between the prevalence of asymptomatic malaria and no history of malaria suffering within that year (p=0.028) and behavior of staying outdoors at night (p=0.019). A low level of knowledge (25.6%) was observed among study participants, coupled with negative attitudes (33.2%) and inappropriate practices (36.1%) towards asymptomatic malaria and its prevention.

— ***Conclusions:*** The observed prevalence of 20.3% (rapid diagnostic test) and 17.7% (microscopy) indicated ongoing transmission of asymptomatic malaria among school-aged children. Hence, there is the need for regular screening and continuing providing health education.

— ***Keywords:*** *Asymptomatic malaria, Risk factors, School aged children, Kibiti district, Tanzania.*

INTRODUCTION

Malaria is one of the most widespread human parasitic diseases responsible for significant morbidity and mortality in tropical and sub-tropical regions. Globally, there was an increase in malaria cases from 227 (2019) to 241 million cases (2020), with 627,000 deaths due to malaria[1]. The increase in malaria cases and deaths were contributed by the disruption of malaria control activities due to Coronavirus Disease-2019 (COVID-19)[1]. Sub-Saharan Africa continues to carry a high number of malaria cases (95%) and deaths (96%)[1]. In 2020, the World Health Organization reported Nigeria (31.9%), the Democratic Republic of the Congo (13.2%), and Tanzania (4.1%) being the leading countries in terms of malaria deaths[1].

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Malaria transmission occurs through the bite by a female Anopheles mosquito infected with *Plasmodium spp*[1]. A person with malaria presents with fever, malaise, fatigue, chills, and rigors. If left untreated usually develops into a severe form of the disease, affecting all body organs resulting in hypoglycemia, coagulopathy, altered mental state, seizure, renal insufficiency, liver failure, and anemia[1].

Asymptomatic malaria is the presence of malaria parasites in individual blood without an individual showing any symptoms of fever or acute illness[2]. Individuals with asymptomatic malaria serve as the potential reservoir of malaria parasites and transmit the *Plasmodium* parasites to uninfected female Anopheles mosquitoes[3]. Asymptomatic malaria is associated with a transition to clinical (symptomatic) malaria, increased risk of anemia, and impairment of cognitive development[4,5]. School-aged children carry more than 60% of the burden of asymptomatic malaria. However, they are given less emphasis on malaria prevention interventions[6].

Malaria transmission in Tanzania varies significantly across the regions, with approximately 59,732,214 million people at risk of acquiring malaria[7]. The overall prevalence of malaria in Tanzania mainland was reported to be 9%, with a low prevalence of 1.4% in the Northern Zone and a high prevalence of 27.7% in the Western zone[8]. With the ongoing burden of malaria, several malaria control measures have been implemented, including the distribution of insecticide-treated mosquito nets (ITNs), indoor residual spraying (IRS) in the western zone, intermittent preventive treatment of pregnant women (IPTp), and management of clinical cases with artemisinin-based combination therapies (ACTs)[9]. The implemented control measures have reduced malaria transmission, morbidity, and mortality[10]. With the decline of the malaria burden, periodic monitoring of asymptomatic malaria is crucial because it can affect the ongoing malaria elimination strategies[10].

Kibiti is among the malaria-endemic district with a previous prevalence of 13%[8]. The observed prevalence is higher than the overall national prevalence[8]. Unfortunately, the factors that have contributed to the persistent transmission of malaria despite the ongoing control measures remain unknown. Therefore, this study was conducted to investigate the burden of asymptomatic malaria and risk factors among school-aged children in the Kibiti district. The finding of this study will provide the current burden of asymptomatic malaria among school-aged children in Kibiti, which will be useful in planning effective strategies to control malaria in school-aged children.

SUBJECTS AND METHODS

Study Design and Settings

A school-based cross-section study was carried out in the Kibiti district from June to July 2021 to investigate the prevalence of asymptomatic malaria and associated risk factors among school-aged children. Kibiti district is one of the seven districts of the Coast region. The district lies between the latitude of 7° 43' 18" S and the longitude of 38° 56' 14" E with an approximate population of 30,163 (14,636 aged 0-14 years)[11]. All the 16 wards (administrative divisions) in the Kibiti district are endemic to malaria. This district experiences seasonal rains, which favor the survival and breeding of the mosquitoes that transmit malaria.

Study Population, Inclusion, and Exclusion Criteria

The study population was primary school children aged between 7-14 years, with no fever in the previous 48 hours, who did not use anti-malaria in the last two weeks, and whose parent/guardian consented to participate in the study by signing the informed consent. Children who could not communicate due to medical conditions such as hearing loss, speech problems and severe stuttering were excluded.

Sample Size Determination and Sampling Procedures

The sample size of primary children was estimated using the formula for cross-sectional surveys ($n = z^2 P (100-P)/\varepsilon$)[12], whereby n was the minimum required sample size, p was the prevalence of asymptomatic malaria (5.4% prevalence of asymptomatic malaria in Morogoro[3]), z was the standard normal deviate of 1.96 on using a 95% confidence interval, and ε was the margin of error (3%). The calculated sample size (218) was adjusted by a 10% non-response rate and the designing effect (1.5). Hence, the minimum required sample size was 360 primary children. The multi-stage sampling technique was used to recruit the 360 primary children. In the first stage, one of the sixteen malaria-endemic wards named Kibiti was selected randomly. In the second stage, two villages (Kibiti A and Kibiti B) from the Kibiti ward were selected. In the third stage, one primary school from each of the two villages was randomly selected. Hence, Kibiti and Kitundu primary schools were selected from Kibiti A and Kibiti B villages, respectively, to participate in this study. A total of 140 and 220 primary children were selected from Kibiti and Kitundu primary schools, respectively. However, in Kibiti primary school, only 96 students participated in the study, resulting in a total sample size of 316 and not 360. Failure of the child to participate was due to parent/guardian refusal, fear of blood sampling, or non-participation in the questionnaire.

Data Collection Tool

Questionnaire survey

A structured questionnaire gathered information on malaria from the selected primary children. The questionnaire was divided into five sections, whereby section A

collected the participant's socio-demographic characteristics. Section B collected the risk factors for asymptomatic malaria. Section C questions examined the participant's knowledge of asymptomatic and symptomatic malaria. The statements of Section D and E examined the participant's attitudes and practices toward malaria transmission, treatment, and prevention.

Blood collection and processing

The finger-prick blood samples were collected from the primary children to assess the presence of asymptomatic malaria using malaria rapid diagnostic test (RDT) [CareStart™ Malaria Pf (HRP2) Ag RDT]. The prepared RDTs were processed and interpreted per the manufacturer's directives. A thick film was prepared for screening and quantification of the malaria parasites microscopically. The prepared slides were fixed with absolute methanol and stained with Giemsa (10%) for 30 minutes. Then, the slides were washed gently with water, air-dried, and examined under the microscope (X100) using immersion oil. The parasite density was determined by counting parasites present per 200 white blood cells. Then, the obtained number was multiplied by 40 under the assumption that each microliter (μL) of blood contains 8,000 white blood cells. The blood smears were negative when no parasites were seen in the 100 fields examined[13].

Quality control

The questionnaire was pre-tested at Bungu Primary School. The primary school used for the pretesting questionnaire was excluded from data collection. The pretesting involved 36 primary children (10% of the estimated sample size). The prepared blood smears were read twice separately by two experienced laboratory scientists. Laboratory scientists were blinded of RDT results. In the event of a disagreement on parasite density, the average of the two results was taken.

Statistical Analysis

The data were analyzed using a statistical package for the social sciences (SPSS) version 24 (IBM Corp., Armonk, NY, USA). The descriptive statistic was employed to summarize the categorical variables to the frequencies with proportions and 95% confidence intervals. The prevalence of asymptomatic malaria and parasite density was summarized further according to the socio-demographic characteristics of the children. The calculated mean parasite density (1843) was employed to classify parasite density as low or high. The children with parasites ≤ 1843 were categorized as having low parasite densities, while those with parasites ≥ 1844 had high parasite densities. The Chi-square test was used to test for the association between the dependent variable (prevalence of asymptomatic malaria) and independent variables (sex, age, class, and school) at the significance level of 0.05.

Knowledge was measured using eight multiple choices carrying a weight of 18 marks. The participant's responses were scored as one for correct answer and zero for incorrect answer. Then, the total score for each participant was calculated, ranging from a scale of 0-18 marks. The classification was as follows; 0-5 marks = low level of knowledge, 6-11 marks = moderate level of knowledge, and 12-18 marks = high level of knowledge.

Attitudes were measured using a five-point Likert scale, while practices used a three-point Likert scale. The reliability test for the ten attitude statements and ten practice statements was performed, and Cronbach's alpha values of 0.617 and 0.653, respectively, were obtained. For attitudes, the sum score for each participant was calculated and ranged from 10 to 50. Then, the mean attitude score of all participants (33.34) was used to classify the attitudes as positive or negative. The participants who scored ≥ 33 were classified as having positive attitudes on malaria transmission, treatment, and prevention, while those who scored ≤ 32 had negative attitudes.

For practices, the sum score for each participant was calculated and ranged from 10 to 30. Then, the mean practice score of all participants (27.43) was used to classify the practices as appropriate or inappropriate. The participants who scored ≥ 27 were classified as having appropriate practices in malaria treatment and prevention, while those who scored ≤ 26 had inappropriate practices.

Ethical Consideration

Ethical approval was sought from the Muhimbili University of Health and Allied Sciences Review Board (Ref. No. DA.282/298/01K). Permission to conduct the study in Kibiti District was requested from all administrative authorities of the Coast region and Kibiti District. The written informed consent forms were given to the selected primary children and instructed to bring them to their parents/guardians for reading and to sign if they allowed their children to participate in the study. The children infected were referred to the nearest health center for treatment. All participant pieces of information were handled by authorized personnel and treated with the highest level of confidentiality.

RESULTS

Socio-Demographic Characteristics of the Study Participants

A total of 316 primary school children were recruited for this study, with response rate of 87.7%. More than half of the participants (62.7%) were females, the majority of the study participants were aged between 11-14 years (87.7%), and more than one-third (40.8%) were standard seven students (Table 1).

Table 1. Socio-demographic characteristics of the study participants (n=316).

Socio-demographic characteristics	N (%)	95% CI
Sex		
Male	118 (37.3)	32.5-42.4
Female	198 (62.7)	57.6-67.5
Age groups (years)	**12.28 ±1.39**	
7-10	39 (12.3)	8.5-16.1
11-14	277 (87.7)	83.9-91.5
Class		
Standard IV	15 (4.7)	2.5-7.3
Standard V	94 (29.7)	25-35.4
Standard VI	78 (24.7)	19.9-29.8
Standard VII	129 (40.8)	35.4-46.9
School		
Kibiti Primary School	96 (30.4)	25.6-35.4
Kitundu Primary School	220 (69.6)	64.6-74.4

Prevalence of Asymptomatic Malaria Among Study Participants

The overall prevalence of asymptomatic malaria by RDT and microscopy was 20.3% (95% CI 15.8-25.3) and 17.7% (95% CI 13.6-23.7), respectively. The prevalence of asymptomatic malaria by RDT and microscopy was high in males (23.7% and 20.3%), age group 7-10 years (23.1% and 17.9), and standard six students (24.4% and 19.2%), respectively. The parasite density ranged from 129-6432, with a mean parasite density of 1862 ± 1795. The high parasite density was found among females (31.2%), age group 11-14 years (30.6%), and standard four children (50%). There was no statistically significant association between the prevalence of asymptomatic malaria and socio-demographic characteristics of the study participants, as presented in Table 2.

Risk Factors Associated with Asymptomatic Malaria Among the Study Participants

The majority of the participants (75.9%) reported owning ITNs. Of those who owned ITNs, 89.2% reported using the ITN always. Nearly half of the participants (44.6%) had a history of malaria one to two times within the year of the study. Only a few participants (17.1%) reported staying outdoors at night. A high prevalence of asymptomatic malaria was observed among the participants who had never used ITNs (33.3%), reported staying outdoors at night (25.5%), and participants with no history of malaria suffering within that year (27.8%). There was a statistically significant association between the prevalence of asymptomatic malaria and no frequency of malaria illness within that year (p=0.028) and behavior of staying outdoors at night (p=0.019) (Table 3).

Knowledge of the Study Participants on Malaria

All study participants had heard of asymptomatic malaria, with the leading source of information being school (29.1%). The vast majority of the participants (92.4%) correctly mentioned biting by the infected female Anopheles mosquito as the mode of malaria transmission. All study participants knew asymptomatic malaria has no symptoms, with the most mentioned symptoms of symptomatic malaria being fever and headache (20.6%). The use of ITNs (32%) was the most recommended way of malaria prevention by participants (***Supplementary Table I***).

Classification of the Level of Knowledge of the Study Participants

Out of the 316 participants, more than half (59.5%) had a moderate level of knowledge on malaria, and a quarter (25.6%) had a low level of knowledge (Table 4).

Table 2. Prevalence of asymptomatic malaria and parasite density among the study participants (n=316).

Socio-demographic characteristics	Participants (%)	RDT Positive (%)	p-value	Microscopy Positive (%)	p-value	Parasite density		p-value
						High	Low	
Sex								
Male	118 (37.3)	28 (23.7)	0.249	24 (20.3)	0.347	7 (28.0)	18 (72)	0.790
Female	198 (62.7)	36 (18.2)		32 (16.2)		10 (31.2)	22 (68.8)	
Age groups (years)								
7-10	39 (12.3)	9 (23.1)	0.671	7 (17.9)	0.968	2 (25.0)	6 (75.0)	0.748
11-14	277 (87.7)	55 (19.9)		49 (17.7)		15 (30.6)	34 (69.4)	
Class								
Standard IV	15 (4.7)	3 (20)	0.638	2 (13.3)	0.558	1 (50.0)	1 (50.0)	0.605
Standard V	94 (29.7)	20 (21.3)		20 (21.3)		6 (28.6)	15 (71.4)	
Standard VI	78 (24.7)	19 (24.4)		15 (19.2)		5 (33.3)	10 (66.7)	
Standard VII	129 (40.8)	22 (17.1)		19 (14.7)		5 (26.3)	14 (73.3)	
School								
Kibiti Primary School	96 (30.4)	23 (24)	0.176	20 (20.8)	0.339	4 (19)	17 (81.0)	0.174
Kitundu Primary School	220 (69.6)	41 (18.6)		36 (16.4)		13 (36.1)	23 (63.9)	

Table 3. Risk factors associated with asymptomatic malaria among the study participants.

Risk factors	n (%)	Positive by RDT	*p*-value
ITN ownership			
Yes	240 (75.9)	50 (20.8)	0.648
No	79 (24.1)	14 (18.0)	
ITN use			
Always	214 (89.2)	44 (20.6)	0.858
Sometimes	23 (9.6)	5 (21.7)	
Never	3 (1.3)	1 (33.3)	
Frequency of illness within that year			
1-2 episodes	141 (44.6)	28 (19.9)	0.028*
3+ episodes	78 (24.7)	9 (11.5)	
None	97 (30.7)	27 (27.8)	
Stagnant water around the home			
Yes	98 (31.0)	15 (15.3)	0.142
No	218 (69.0)	49 (22.5)	
Staying outdoors overnight			
Often	54 (17.1)	4 (7.4)	0.019*
Sometimes	125 (39.6)	25 (20)	
No	137 (43.4)	35 (25.5)	
Home windows covered with nets			
Yes	252 (79.7)	53 (21)	0.494
No	64 (20.3)	11 (17.2)	
House sprayed with IRS			
Yes	0 (0)		-
No	316 (100)	64 (100)	

*Statistically significant $p<0.05$

Attitudes of the Study Participants on Malaria

The majority of the participants either agreed (36.4%) or strongly agreed (45.6%) that asymptomatic malaria is among the life-threatening diseases. More than one-third of the participants either agreed (36.1%) or strongly agreed (4.7%) that it is important to perform a regular screening for asymptomatic malaria. More than a quarter of the participants (27.8%) were not sure if some portion of asymptomatic infections may become symptomatic. Almost a quarter of the participants (24.1%) were not sure if they were at risk of acquiring asymptomatic malaria when not sleeping under the ITN. Most of the participants either agreed (37%) or strongly agreed (47.2%) that children are the most vulnerable population at risk of acquiring asymptomatic malaria compared to adults (***Supplementary Table II***).

Classification of Attitudes of the Study Participants on Malaria Transmission, Treatment and Prevention

Of the 316 participants, about two-thirds (66.8%) had positive attitudes towards malaria transmission, treatment, and prevention (Figure 1).

Table 4. Classification of the level of knowledge (n=316).

Classification	n (%)	95% CI
Low level of knowledge	81 (25.6)	21.2-30.4
Moderate level of knowledge	188 (59.5)	53.8-64.6
High level of knowledge	47 (14.9)	10.4-19.6

Practices of the Study Participants on Malaria Treatment and Prevention

Most of the participants always slept under mosquito nets (79.4%) and applied mosquito repellent whenever outdoors at night (72.2%) to prevent mosquito bites. About half of the participants (50.6%) reported using the anti-mosquito spray at home to kill the mosquitoes. Only 23.7% of the participants reported going to the hospital with their parents for malaria checkups. About 21.5% of the participants reported the practice of closing the windows and doors to prevent mosquito entry into the house (Table 5).

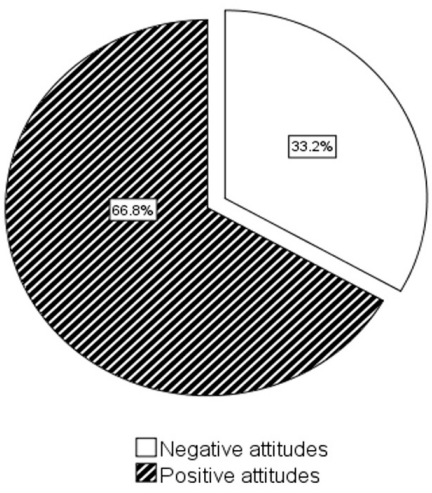

Figure 1. Attitudes of the study participants towards malaria.

Table 5. Practices of the study participants (n=316).

Statements	Always	Sometimes	Never
I usually sleep under the ITNs	251 (79.4)	48 (15.2)	17 (5.4)
Parents/guardians repairs holes in the mosquito nets	253 (80.1)	40 (12.7)	23 (7.3)
We drain stagnant water near home	209 (66.1)	78 (24.7)	29 (9.2)
When outside the house at night, I apply the mosquito repellent	228 (72.2)	70 (22.2)	18 (5.7)
We use mosquito coils for prevention of malaria at home	75 (23.7)	206 (65.2)	35 (11.1)
We use the anti-mosquito spray at home	160 (50.6)	118 (37.3)	38 (12)
I wear trousers and long sleeve shirt when outside at night	143 (45.3)	115 (36.4)	58 (18.4)
We use the mosquito repellent coils at home	163 (51.6)	103 (32.6)	50 (15.8)
I usually go to the hospital with my parents/guardians for asymptomatic malaria checkups	128 (40.5)	119 (37.7)	69 (21.8)
At home, we usually close the windows and doors to prevent mosquito entry into the house	112 (35.4)	136 (43.0)	68 (21.5)

Classification of Practices of the Study Participants on Malaria Treatment and Prevention

Of the 316 participants, nearly two-thirds had appropriate practices (63.9%) towards malaria transmission, treatment, and prevention (Figure 2).

DISCUSSION

In the present study, the prevalence of asymptomatic malaria by RDT and microscopy was 20% and 17%, respectively. The observed prevalence is high than the reported findings from studies[15,16] conducted in the coastal area (Morogoro region and Bagamoyo district) which revealed a prevalence of 5.4 and 7.6% on RDT and microscopy, respectively in the Morogoro region and 14 and 8% on RDT and microscopy, respectively in Bagamoyo district. The increase in the prevalence of asymptomatic malaria could be due to Coronavirus disease-2019, which caused the interruption of malaria control interventions. The prevalence of asymptomatic malaria was high among male children compared to female children. This contrasts with most studies[3,14] in which high prevalence was among female children. During Coronavirus disease-2019, schools were closed, and children had ample time to play with male children playing till late evening hence, frequent exposure to malaria vectors. Also, a high prevalence of asymptomatic malaria was observed in children aged 11-14 years compared to children <10 years, in contrast to a study conducted in Morogoro[3]. The high parasite density was in children aged 11 to 14 years compared to the group of <10 years which might be due to repeated exposure to malaria infection. The observation is in contrast with the findings from other scholars[15], reporting the increase in age is associated with low parasite density in school-aged children.

Most of the children (76%) owned ITN; this is similar to the findings of the Tanzania Malaria Indicator Survey of 2017, in which ITN ownership was 78%[3]. A high prevalence of asymptomatic malaria was found among those who had never used ITN; this is due to the increased risk of exposure to mosquito bites. There was a statistically significant association between the prevalence of asymptomatic malaria and staying outdoors at night. Staying outdoors at night without any protective measures increases the chance of being bitten by mosquitoes. The findings are in line with studies that were conducted elsewhere[16,17]. Also, there is evidence of Anopheles mosquitoes exhibit more exophilic behaviors than endophilic behaviors. Hence, contributing to the risk of malaria transmission and acquisition[16,18]. There was a statistically significant association between the prevalence of asymptomatic malaria and the frequency of symptomatic malaria illness within that year. The high prevalence of asymptomatic malaria (27.8%) was in participants who had no history of malaria suffering within that year compared to those who had 1-3 episodes. It could be due to a lack of regular checkups compared to the groups who had malaria episodes and received treatment. The observation agrees with a study in Ethiopia which reported a high prevalence of asymptomatic malaria in participants who had a history of more than five episodes of malaria[19].

All of the participants had heard of asymptomatic malaria, possibly because of the high endemicity of symptomatic malaria and its ongoing interventions for prevention. The findings contrast with a study that re-

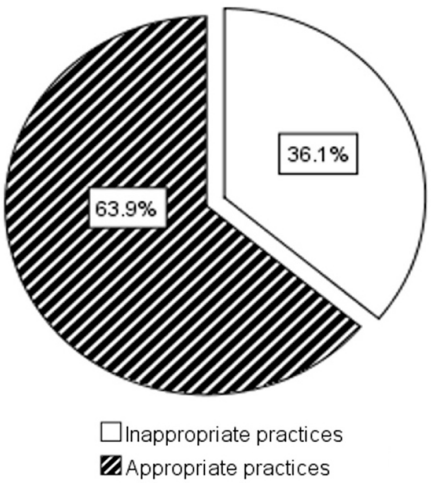

Figure 2. Practices of the study participants towards malaria.

ported a high awareness of symptomatic malaria and low awareness of asymptomatic malaria[20]. The majority of participants knew the correct mode of disease transmission (biting by infected female anopheles), especially at night, asymptomatic malaria has no symptoms, symptoms of symptomatic malaria, use of ITN every night as a means of malaria prevention, and going to the hospital and diagnosis as a means of proper treatment of symptomatic malaria. It might be due to health education on malaria provided at the schools and health centers. However, a quarter of the study participants had asymptomatic and symptomatic malaria low knowledge levels. The group could compromise the ongoing effort to control malaria in the area as it will affect their attitudes and prevention practices. Studies[21-23] in Tanzania have established knowledge levels on symptomatic malaria with limited information on asymptomatic malaria knowledge levels. A study[20] in Laos has reported low awareness and partial understanding of asymptomatic malaria in endemic countries.

Positive attitudes and appropriate practices play a significant role in asymptomatic malaria reduction[21,24]. Negative attitudes toward asymptomatic malaria could potentially affect the prevention practices. In this study, about one-third of the participants (33.2%) had negative attitudes towards asymptomatic malaria. It could be contributed by the group which had asymptomatic malaria low level of knowledge. About 40.8% agreed it is important to do a regular screening for asymptomatic malaria, which could influence the appropriate practices of regular screening. Also, about 24.1% were not sure if they were at risk of acquiring asymptomatic malaria when they do not sleep under the ITN which could result in inappropriate practices regarding the use of ITNs. On preventive practices, despite the high awareness of asymptomatic malaria, more than one-third (36.1%) had inappropriate practices towards asymptomatic malaria prevention. The observed inappropriate practices could also reflect symptomatic malaria prevention practices. The top three preventive practices were sleeping under ITN, mosquito repellents use, and draining the breeding sites. These measures are affordable and widely reported for malaria prevention[21,24].

LIMITATIONS

The prevalence of asymptomatic malaria could be high than the observed prevalence. We did not use the PCR technique for the diagnosis, hence a possibility of those with low parasitemia not detected by RDT and microscopy. The questionnaire used relied on the self-reporting of the information, thus might result in over or underestimation of the findings. It could have been more reliable to have a checklist for the observation.

CONCLUSIONS AND RECOMMENDATIONS

There is a high prevalence of asymptomatic malaria (20.3% by RDT and 17.7% by microscopy) among the school-aged students in the Kibiti district. The statistically significant risk factors triggering a high prevalence of asymptomatic malaria in the area were the behavior of staying outdoors overnight and the frequency of malaria illness within that year. Also, low knowledge level coupled with negative attitudes and inappropriate practices toward asymptomatic malaria was observed among the study participants, thus hampering the ongoing malaria control efforts in the area. Therefore, the government, through National Malaria Control Programme, should organize regular check-ups at the school for the early detection of malaria parasitemia. Also, there is a need to continue providing health education to school-aged children to improve their knowledge of asymptomatic malaria and change negative attitudes and inappropriate practices observed.

Conflict of interest:
The authors declare that they have no conflict of interest.

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REFERENCES

1. WHO. Malaria. Geneva, World Health Organization. Available from: https://www.who.int/news-room/fact-sheets/detail/malaria [Accessed: 6 April 2022]
2. Kumari P, Sinha S, Gahtori R, Yadav CP, Pradhan MM, Rahi M, Pande V, Anvikar AR. Prevalence of Asymptomatic Malaria Parasitemia in Odisha, India: A Challenge to Malaria Elimination. Am J Trop Med Hyg 2020; 103: 1510-1516.

3. Nzobo BJ, Ngasala BE, Kihamia CM. Prevalence of asymptomatic malaria infection and use of different malaria control measures among primary school children in Morogoro Municipality, Tanzania. Malar J 2015; 14: 491.
4. Clarke SE, Rouhani S, Diarra S, Saye R, Bamadio M, Jones R, Traore D, Traore K, Jukes MC, Thuilliez J, Brooker S, Roschnik N, Sacko M. Impact of a malaria intervention package in schools on Plasmodium infection, anaemia and cognitive function in schoolchildren in Mali: a pragmatic cluster-randomised trial. BMJ Glob Health 2017; 2: e000182.
5. Gudo ES, Prista A, Jani IV. Impact of asymptomatic Plasmodium falciparum parasitemia on the imunohematological indices among school children and adolescents in a rural area highly endemic for Malaria in Southern Mozambique. BMC Infect Dis 2013; 13: 1-8. Available from: https://bmcinfectdis.biomedcentral.com/articles/10.1186/1471-2334-13-244
6. Zerdo Z, Bastiaens H, Anthierens S, Massebo F, Masne M, Biresaw G, Shewangizaw M, Tunje A, Chisha Y, Yohannes T, Van Geertruyden JP. Long-lasting insecticide-treated bed net ownership, utilization and associated factors among school-age children in Dara Mallo and Uba Debretsehay districts, Southern Ethiopia. Malar J 2020; 19: 369.
7. Malaria in Tanzania: Statistics & Facts | Severe Malaria Observatory. Available from: https://www.severemalaria.org/countries/tanzania [Accessed: 6 April 2022]
8. Tanzania Bureau of Statistics. Tanzania Demographic and Health Survey and Malaria Indicator survey of 2015–16. Dar es Salaam, 2016.
9. President's Malaria Initiative. Malaria Operational Plan Tanzania, FY 2013. http://www.pmi.gov/countries/mops/fy13/liberia_mop_fy13.pdf. [Accessed: 6 April 2022]
10. Kalinga AK, Kavishe RA, Ishengoma DS, Kagaruki GB, Mweya CN, Temu L, et al. Prevalence of asymptomatic Malaria infections in selected military camps in Tanzania. Tanzan J Health Res 2019; 21: 1-11.
11. Kibiti DC. Statistics of Kibiti, Coast Region, Tanzania. Available from: https://www.mindat.org/feature-157977.html [Accessed: 6 April 2022]
12. Creswell JW. Research Design: Qualitative, Quantitative and Mixed Method Aproaches. SAGE Publ. 2007.
13. WHO. (2010a). Basic Malaria Microscopy: Part 1. Learner's guide: Second Edition.
14. Sumari D, Mwingira F, Selemani M, Mugasa J, Mugittu K, Gwakisa P. Malaria prevalence in asymptomatic and symptomatic children in Kiwangwa, Bagamoyo district, Tanzania. Malar J 2017; 16: 222.
15. Nankabirwa J, Brooker SJ, Clarke SE, Fernando D, Gitonga CW, Schellenberg D, Greenwood B. Malaria in school-age children in Africa: an increasingly important challenge. Trop Med Int Health 2014; 19: 1294-309.
16. Bradley J, Lines J, Fuseini G, Schwabe C, Monti F, Slotman M, Vargas D, Garcia G, Hergott D, Kleinschmidt I. Outdoor biting by Anopheles mosquitoes on Bioko Island does not currently impact on malaria control. Malar J 2015; 14: 170.
17. Shimizu S, Chotirat S, Dokkulab N, Hongchad I, Khowsroy K, Kiattibutr K, Maneechai N, Manopwisedjaroen K, Petchvijit P, Phumchuea K, Rachaphaew N, Sripoorote P, Suansomjit C, Thongyod W, Khamsiriwatchara A, Lawpoolsri S, Hanboonkunupakarn B, Sattabongkot J, Nguitragool W. Malaria cross-sectional surveys identified asymptomatic infections of Plasmodium falciparum, Plasmodium vivax and Plasmodium knowlesi in Surat Thani, a southern province of Thailand. Int J Infect Dis 2020; 96: 445-451.
18. Kikompolisi G, Emidi B, Ngasala B. Infuence of Indoor Residual Spray on An . gambiae S . L . and An . funestus Abundance , Resting Behavior and Community Perception on IRS Intervention. Available from: https://www.researchsquare.com/article/rs-948331/v1 [Accessed: 10 April 2022]
19. Worku L, Damtie D, Endris M, Getie S, Aemero M. Asymptomatic Malaria and Associated Risk Factors among School Children in Sanja Town, Northwest Ethiopia. Int Sch Res Notices 2014: 303269.
20. Adhikari B, Phommasone K, Pongvongsa T, Soundala X, Koummarasy P, Henriques G, Peto TJ, Seidlein LV, White NJ, Day NPJ, Dondorp AM, Newton PN, Cheah PY, Mayxay M, Pell C. Perceptions of asymptomatic malaria infection and their implications for malaria control and elimination in Laos. PLoS One 2018; 13: e0208912
21. Munisi DZ, Nyundo AA, Mpondo BC. Knowledge, attitude and practice towards malaria among symptomatic patients attending Tumbi Referral Hospital: A cross-sectional study. PLoS One 2019; 14: e0220501.
22. Kinung'hi SM, Mashauri F, Mwanga JR, Nnko SE, Kaatano GM, Malima R, Kishamawe C, Magesa S, Mboera LE. Knowledge, attitudes and practices about malaria among communities: comparing epidemic and non-epidemic prone communities of Muleba district, North-western Tanzania. BMC Public Health 2010; 10: 395.
23. Mathania MM, Kimera SI, Silayo RS. Knowledge and awareness of malaria and mosquito biting behaviour in selected sites within Morogoro and Dodoma regions Tanzania. Malar J. 2016;15(1). Available from: https://pubmed.ncbi.nlm.nih.gov/27216605/
24. Flatie BT, Munshea A. Knowledge, Attitude, and Practice towards Malaria among People Attending Mekaneeyesus Primary Hospital, South Gondar, Northwestern Ethiopia: A Cross-Sectional Study. J Parasitol Res 2021; 2021: 5580715.