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Contributing Factors for Increasing Incidence of Malaria in Talata Asher Village, Tesseney District, Gash Barka, Eritrea 2023

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ABSTRACT

Background: The expansion of new malaria vector knows to call An. stephensi in Sub-Saharan-Africa (SSA) is another challenge in malaria elimination. The use of long lasting insecticidal net(LLINs) ,indoor residual spraying (IRS) and environmental management targeted to eliminating mosquitoes breeding sites is the main malaria prevention strategies. This study aimed at assessing the factors for increasing incidence of malaria in talataasher village, teseney district gash barka region of Eritrea.

Methods: The quantitative descriptive cross sectional & qualitative study was conducted in Talata Asher village, Tesseney district, Gash barka, Eritrea which is found in gash barka, Eritrea in border with Sudan. A total of 102 households interviewed, 10 households for indoor breeding site assessment, 10 outdoor breeding habitat for outdoor breeding assessment and also twelve participants for focus group discussion. Data was collected using a standard structured questionnaire, standard entomological forms and analyzed using SPSS version 2025.

Results: Of the 102 households assessed 92.2% of the households own at least one LLINs, 73.2% two or more LLINs. Only about 23% of all households had sufficient numbers of LLINs to meet the desired target in the household. Nearly 87.2 % of household members were used the net for sleeping under, but only 52.9% slept under LLINs during the previous night. The majority of the house holds 40.4 % were slept under LLINs after ten pm. Out of the total 60% of the households mentioned only one environmental management campaign performed through the whole year in the area. With regards to the total morphologically identified Anopheles from the artificial and natural breeding habitat, 34.3% and 27.9% were An.stephensi which is the new emerging malaria vector respectively.

Conclusions: The low bed net utilization and practice of environmental management targeted to malaria prevention results the increasing malaria incidence in study site. In addition, to that the presence of new emerging malaria vector An. Stephensi in the study area also the cause increased incidence. Therefore there is a need to a special attention on the behavior of the new vector and a need to promote the whole population on the core malaria prevention methods.

Keywords: An. Stephensi, Long-lasting insecticidal nets, Talata Asher village

INTRODUCTION

Malaria remains a major public health problem in many parts of the world, particularly in sub-Saharan Africa, where more than 95% of cases occur (1). Although impressive gains have been achieved in reducing the incidence of the disease since 2000, progress has slowed in recent years, with some countries registering increases in burden. In response to the stalling of progress, the World Health Organization (WHO) and the RBM Partnership to End Malaria launched the "high burden to high impact" approach (2). Also more than half of malaria-endemic countries now have fewer than 10 000 cases each year and are close to malaria elimination (1). To support their efforts, WHO launched the E-2020 initiative, later progressing to the E-2025 initiative, to accelerate malaria elimination in several countries that have a very low burden of malaria (3)

In the country about 46.5% of Eritrean population live in the zones classified as moderate malaria risk zones, Gash Barka and south and the remaining 53.5% live in the low risk zone of Anseba,Center ,Northern red sea and southern red sea(4). Since 2019 the incidence of malaria has increased nationwide. In 2022 the incidence of malaria cases in teseney sub zone has also increased by 21.9 % from the level of 2021.the same increasing was showing in the study site (talataasher) by 16.5% from the level of 2021(5).

Malaria is a complex diseases transmitted by blood feeding mosquitoes (Dutta and Dutt, 1978). Globally 70-80 species of anopheles mosquitoes are known to transmit malaria (6). However, over 3,500 mosquitoes have been recorded from all corners of the world (7). In Africa, twenty anopheles mosquitoes are known to transmit malaria from the total 140 identified anopheles species (8). In Eritrea, 13 species were identified in 2001 Vis; An. gambaie, An. d'thali, An. squemosus, An. cinereus, An. rhondesiensis, An. rupicolus, An. harperi, An. demoilloni, An. garnhami, An. funestus, An. chrysti, An. wellcomi, An. pharoensis, with the dominance of An. Gambiaewhich accounts for more than 80% of the total (9).

Climate changes have been playing a great role in the distribution and diversity of malaria vectors. Thus, the geographical location of malaria and length of seasons of suitability might be changing. A study by Ryan et al (2020) revealed, in West Africa for example an approximately additional 51.3 million people will be at risk of malaria at the midcentury (10). Climate conditions are directly associated with elevation. Temperature decreases as elevation increases and consequently the abundance and species composition of malaria vectors may change with elevation. A study in Kenya found no An. arabiensis were found in areas with elevation around 1500 meter above sea level (11).

The expansion of new malaria vector knows to call An. stephensi in Sub-Saharan-Africa (SSA) is another challenge in malaria elimination which will responsible for additional126 million people from urban areas to be at risk of malaria (12).Vector control is a cornerstone of malaria control and it remains the most generally effective measure to prevent malaria transmission and therefore is one of the strategic approaches to malaria control (13). The objectives of malaria vector control are two-fold to protect individual people against infective malaria mosquito bites, and to reduce the intensity of local malaria transmission at community level by reducing the longevity, density and human-vector contact of the local vector mosquito population. Vector control methods vary considerably in their applicability, cost and sustainability of their results. They target against the adult mosquito and/or its larvae. Vector control methods Interventions using vector control methods are related to the following three major control mea-

sures:

- Reducing human-vector contact: Insecticide-treated mosquito nets, Improvedhousing, Repellents and mosquito coils
- Adult mosquito control : Insecticide-treated mosquito nets , Indoor residual spraying , Space spraying
- Larval control:Larviciding, Source reduction, Larvivorous fish

Not all of these methods are applicable to all of the diverse malaria epidemiological and operational situations that can occur. The two most powerful and most broadly applied vector control interventions are long lasting insecticide-treated mosquito nets (LLIN) and indoor residual spraying (IRS)(13).These interventions work by reducing human-vector contact and by reducing the lifespan of female mosquitoes. Other interventions, such as Larviciding or environmental management, can be useful in a specific set of conditions, depending on the target vector and the local situation. Due to logistical and operational limitations, these methods cannot be efficiently implemented in all areas but can in specific settings play a complementary role to insecticide-treated mosquito nets and indoor residual spraying. Larviciding is useful only where breeding sites are few, fixed and findable.Vector control methods vary in efficacy, resource requirements, potential delivery systems, and personnel required to implement the method. Some methods are highly specific and others broad ranging (13).

2.METHODOLOGY

2.1 Study design and study area

The quantitative descriptive cross sectional & qualitative study was conducted in Talata Asher village, Tesseney district, Gash barka, Eritrea which is found in gash barka, Eritrea in border with Sudan. The village includes almost all Eritrean ethnic groups and it founds 385 km to the west from the capital city of Eritrea, Asmara. It lies at latitude $15^0$6'53" n longitude $36^0$39'46" e and elevation of 600m above sea level (using GPS) which is one of the hottest villages of gash barka. The total population in this village was around 7000. The economic income depends mostly on farming and animal rising, and small parts of them are merchants it is also known as land port with Sudan. Talata Asher is situated along Gash River which is the permanent breeding site. The entire breeding site treated by temophos and bti to control the larvae as well as organophosphates, carbamates and also recently we are using the combined insecticide fludora fusion (clothianidin & deltametrine) for IRS in rotation every two years to control adult mosquitoes. Pyrethroids are used only for long lasting impregnated net in this site.

2.2 Sampling size andSampling technique

A convenient sampling was used to select the site (village) which was previously with high incidence of malaria in teseney sub zone. The selection of the study site was based on current malaria burden and availability of active breeding habitats. Therefore randomly 102 households for bed net utilization and source reduction activity assessment, 10 households for indoor breeding site assessment, 10 outdoor breeding habitat for outdoor breeding assessment and also twelve participants for focus group discussion (FGD)were selected.

2.2.1 Focus group discussion (FGDs)

The focus group dissuasion were conducted with village community member from various socio-economic backgrounds taking in to account for fair representation of both genders .One core group of discussion consists of village elders, women, youth and other appropriate groups or persons . The FGDs

that were undertaken consisted of twelve participants.

2.3 DATA COLLECTION, MANAGEMENT AND ANALYSIS

Data was collected using a standard structured questionnaire, standard entomological forms. All was recorded on standardized forms, enter into an Excel database and then imported into SPSS version 22, for statistical analysis. Also deductive data analysis was used for the analysis of FGD.

4. RESULTS

4.1. Characteristics of the breeding sites

During the present study only immature mosquitoes were used. Throughout the study, mosquito aquatic stages (larvae/pupae) were collected from the natural and artificial habitats standard dipping methods. A total of ten natural breeding habitats(agricultural irrigation, water source ,ponds and offprint) and ten households for artificial breeding habitat(concrete water container ,metal barrel ,plastic barrel)were assessed . The collected larva and pupa were brought to the mosquito rearing facility at Tesseney town, where they were placed in trays and raised to adult. A dissecting microscope was used to identify emerging adults to the species using identification key.

4.2. Morphological identification of Anopheles mosquitoes

A total of 3486 aquatic stages (larvae and pupae) belonging to two mosquito genera (Anopheles,Culex and Aedes) were collected. Of these, 28.9% were Anopheles spp, 68.8% Culex, 2.3% Aedes and 1.3% were undetermined pupae. 956(27.4%) of the total larvae were collected from the artificial breeding habitat where as 2530 (72.6%) were collected from the natural breeding habitat. The most productive natural and artificial breeding habitats for Anopheles mosquitoes were the agricultural irrigation and water concrete container. (See in table 1 and 2)

Table 1. Classification of mosquito breeding habitats based on larval productivity (artificial breeding habitat)

H.H No	breeding type	Collected mosquitoes			
		Anopheles	Culex	Aedes	Pupa
1	concrete container	80	120	0	5
2	concrete container	40	180	0	0
3	concrete container	36	140	0	0
4	concrete container	0	0	0	0
5	plastic barrel	0	0	0	0
6	plastic barrel	0	0	0	0
7	plastic barrel	0	0	0	0
8	metal barrel	0	200	50	12
9	metal barrel	0	80	30	2
10	metal barrel	0	0	0	0

Table 2. Classification of mosquito breeding habitats based on larval productivity (natural breeding habitat

breeding habitat No	breeding type	No of larvae collected			
		Anopheles	Culex	Aedes	Pupa
1	Agricultural irrigation	305	1003	0	45
2	Agricultural irrigation	195	497	0	17
3	water source	300	102	0	9
4	water source	30	58	0	2
5	water source	10	20	0	0
6	hoof print	0	0	0	0
7	hoof print	0	0	0	0
8	hoof print	0	0	0	0
9	water ponds	50	0	0	0
10	water ponds	0	0	0	0

Out of the total anopheles emerged to adult 70 and 125 from artificial and natural breeding habitat were morphologically identified respectively. With regards to the total identified Anopheles mosquitoes from the artificial breeding habitat, 65.7% were An. Gambiae, 34.3% An. Stephensi which is the new emerging malaria vector .And also 72.1% of the total identified Anopheles from natural breeding habitat were An. Gambia and the remaining 27.9 % were An. Stephensi. (See in table 3)

Table 3. Morphologically identification of Anopheles mosquitoes

Breeding habitat type	sampled Anopheles for identification		identified species	
	indoor collected	outdoor collected	An. Gambia	An.stephensi
concrete containers	70	0	46(65.7%)	24(34.3%)
Agricultural irrigation (concrete)	0	100	63(63%)	37(37%)
water source	0	15	8(53.3%)	7(46.7%)
water ponds	0	10	10 (100%)	0(0%)

4.3. Characteristics of the households

Of the 102 households involved in the community-based survey, 100% were completed the interview In the 102 households successfully interviewed in the study, 648 households member were listed .Of theses 68(10.5%) aged under 5 years old, 224(34.6%) aged between five and fifteen years old and 54.9% were aged above fifteen years old. Out of the total 102 respondent 72(70.6%) were females. The distribution of the respondents by educational level showed that 35(35.3%)of the respondents were not educated,64(62.8%) were educated up to elementary level and only 2(2%) attended higher level.

4.4. Household ownership and utilization of bed nets

The result of the study found to be 94(92.2%) of the households own at least one LLINs, 75(73.5)% two or more LLINs. Only about 24 (23.5%) of all households had sufficient numbers of LLINs to meet the desired target in the household. 8 (7.8%) households didn't have any LLINs during the study period. The

reason of the of household who didn't have it was due to damaged.6(75%) of the total households damaged their LLINs with in the six months and 2(25 %) were before the six months. Nearly 82(87.2 %) of household members were used the net for sleeping under only, but only 54(52.9%) slept under LLINs during the previous night.

The present study revealed that 28(29.8%) households slept under LLINs every night, 16(17%) slept under LLINs four – six days per week, 32(34%) slept under LLINs 1- 3 nights per week. The main reason of the respondent for not use of LLINs were due to they believed that no mosquitoes 243(63.2%) and no malaria 14(36.8%) during the study period.

It is important to note that only 8(8.5%) of the households slept under the LLINs before eight pm, 30(31.2%) between eight pm and ten pm and the majority of the house holds 38(40.4 %) were slept under LLINs after ten pm. (see in table 4)

Table 4: household ownership and utilization of bed nets

Description /characteristics	Number	Percent
Households having at least one LLINs	94	92.2
Households used the net for sleeping under	82	87.2
Households used the net last night	54	52.9
Frequency of used last week		
Every night (7 days)	28	29.8
Most nights (4-6 days)	16	17
Some nights (1-3days)	32	34
Not at all(0)	18	19
Time of sleeping under bed net		
Before 8pm	8	8.5%
Between 8 and 10 pm	30	31.2%
After 10 pm	38	40.4%
No at all	18	19.6
Period of the year the net used under		
Whole year	24	29.3
Only raining season	58	70.7
Reason of the net no longer in the households		
Damaged	8	100
Months the net become unavailable		
<6 months	6	75.0
> 6 months	2	25.0
Reason of the net not used last night		
No malaria	14	36.8
No mosquitoes	24	63.2

4.5. Environmental management

Out of the total 102 respondents, 72(70.6%) believed that mosquitoes can breed only in the presence of water 24(23.5%) believed that mosquitoes can breed in green leafs and the remaining 6(5.9%) didn't

mention any. Similarly 44(43.1%) of the respondents agreed that mosquitoes can breed in artificial breeding sites (water container). Only 17(16.7%) of the respondents seen mosquitoes larvae ,out of them 11(64.7%)of the respondents seen the larvae in the natural breeding sites .(see in table 5)

Table 5: knowledge and altitude on the mosquitoes breeding habitat

Description /characteristics	Number	Percent
Where does mosquitoes breed		
In the presence of water	72	70.6
In green leafs	24	23.5
Don't know	6	5.9
Do mosquitoes breed inside our house (water containers)		
Yes	44	43.1
No	26	25.5
Don't know	32	31.4
Have you ever seen mosquitos' larvae		
Yes	17	16.7
No	85	83.3
Where do you ever seen		
Indoor(water container)	6	35.3
Outdoor (field)	11	64.7

The present study shows that 88(86.3%) of the respondents believed that environmental sanitation is one of the most methods of malaria prevention. Of the total respondents only 30(29.4 %) agreed that their communities practiced environmental sanitation targeting to malaria prevention .Out of them 8(26.7%) respondents mentioned labeling and filled of the breeding sites were performed by the community and 22(73.3%) respondents mentioned collecting potential breeding materials were done by the community during the environmental sanitation campaign .18(60%) of the respondents agreed that environmental sanitation were performed only once per year in their communities , and 12(40 %) of the respondents were agreed two or three times per year.(see in table 6)

Table 6: activity of environmental sanitation

Description /characteristics	Number	Percent
Is environmental sanitation preventing malaria		
Yes	88	86.3
No	2	2.0
don't know	12	11.8
Does your community participate malaria prevention		
Yes	30	29.4
No	52	51.0
dont know	20	19.6
During which period community participate		
only summer season	30	100

Frequency of community participation last year		
Once	18	60
2-3 times	12	40
Type of environmental sanitation		
leveling and filled	8	26.7
collecting potential breeding materials	22	73.3

4.6. Focus group discussion (FGD)

Out of the total twelve except three participants believed that malaria is the normal disease as it can treat by community heath agent and can recover soon after treatment. The remaining ten participants express malaria is one of the burden and life-threatening if not treated soon, and it can affect the community trough different ways (economically, school absenteeism, work absenteeism, some organ damage e.t.c)

Some of the participant explain that while malaria has tremendously decreased the past 10 years, the last two three years become increasing highly .more than half of the participant state that the success of malaria control in our village is the result of concerted efforts of MoH.

The majority of the participant in FGD knows the sign and symptom of malaria .83.3% of the participant in the FGD mentioned the main four preventions method of malaria (LLINs, IRS, LSM, early diagnosis and treatment). All the participant in the FGD express that the community practice in prevention of malaria is not satisfactory despite people have been highly mobilized in controlling malaria every year. For instance Talata asher ,while the local administration organize environmental sanitation targeted to malaria control every weekend, the people simply swipe their compound and put their trash outside in the open ground creating comfortable breeding place.

When we are discussing the utilization of bed net, most of the participant believed that bed net is the most method of malaria prevention through killing the mosquitoes contacting the net and barrier to bite the person. Even though majority of the participants believe there is adequate bed net distribution every three years, only two participants think that people are using them properly and timely. The majority of the participants stated that bed net usage in our village is not properly and not on time. Reason of poor usage bed net explained as there is no mosquitoes, negligence, feels hot, bad smell and no malaria season.

Majority of the participant believed that the main reason of increasing malaria since the last three years was due to very poor practice in prevention of malaria like; no use of bed net, sleeping under bed net after bite by mosquitoes, creating artificial breeding habitat in the households (barrels, concrete containers, pots, tires e.t.c) ,weak environmental managements targeted to malaria prevention(draining, leveling, filling, covering water containers mosquitoes breeding habitats .

Only four participants know and experienced that mosquitoes can breed in natural and artificial breeding habitats. The remaining participants believed that mosquitoes can breed only in natural breeding habitat outside the village. But some of them heard about artificial breeding sites at the recent times.

5. Discussion

This survey investigated that An. stephensi is distributed broadly throughout Eritrea. These data, taken with previous reports of An. stephensi in gash barka in 2023 (14), confirm that An. stephensi is established in this region. The presence of An. stephensi was confirmed using morphological identification method .The invasion and establishment of An. stephensi in the Horn of Africa represents

an imminent and significant regional threat, which may jeopardize malaria control, particularly in urban areas which were formally free from disease transmission (15,16)**.**The present study revealed that the most productive natural and artificial breeding habitats for Anopheles mosquitoes were the agricultural irrigation and concrete container . With regards to the total identified Anopheles from the natural and artificial breeding habitat, 27.9 % and 34.3% were An. Stephensi which the new emerging malaria vector respectively. An. Stephensi shares the same breeding habitat with aedes (Ae.) aegypti. These mosquitoes prefer water holding containers. Water concrete container emerged as the dominant breeding site across study areas. In this region, Similar previous study resulted over 87% of Anopheles stephensi collected from concrete water container .(14)Similarly, while An. stephensi is mostly an urban vector, the species may extend its ecological extents into more rural areas where habitats like streams and irrigation ditches abound. This would further complicate the challenges related to identification and reporting of the vector species beyond the African coastal cities.(17) some of Participants from FGD knew and experienced that mosquitoes can breed in natural and artificial breeding habitats. The remaining participants believed that mosquitoes can breed only in natural breeding habitat outside the village.

Increasing the ownership and use of bed net with introduction of LLINs and also free distribution to pregnant and even to the whole population is one of the core malaria prevention strategy .(18). The present study revealed that 92.2% of the households own at leastone LLINs and 73.2 % own two or more .The result of the study was similar with previous survey conducted in the area (18). Participant from FDG stated that there is no shortage of bed net due to the mass distribution and free distribution to pregnant women. Similar study done in Myanmar Demographic and Health Survey showed greater bed net ownership than our study, in which 97% of the households were found to own at least one mosquito net (19),

The study shows that, however 87.2 % of the households used the LLINs for sleeping under, only 52.9% of the households slept under the LLINs the night before the study date .This finding is similar with the result of survey conducted in gash barka region which accounts 51% (18). According to our study the most common reason for failure in bed net usage was either because of no mosquitoes around and no malaria as mentioned by the respondents 63.2% and 36.8% respectively. The majority of the participants from FDG stated that bed net usage in our village is not properly. Reason of poor usage bed net explained as there is no mosquitoes, negligence, feels hot, bad smell and no malaria .Similarly Even when households had access to LLINs, a considerable proportion did not use them. This has already been observed in other studies conducted in Nigeria, Kenya, and Tanzania (20–22), and may be related to the lack of knowledge on the importance of LLINs or perceived problems of LLINs such as insecticide smell, and their ability to cause dizziness, headaches, or difficulty breathing.

The observed shortages in some household availability may also be partly due to usage for other purposes and/or improper handling. In the present study majority of the households which accounts 40% slept under bed net after ten pm which cause to bite by mosquitoes before the use bed net. Also majority the participant from FDG stated that there was a delay use of bed net. Similarly Study results from focus group discussions in urban Tanzania identified behaviors seen to compromise the effectiveness (and subsequent usage) of bed net use in urban settings and specific targets for SBC promotion. This included bed net sharing by two or more people, people sleeping with body touching the net, seasonal bed net usage (during rainy season only) and going to bed after already being bitten outdoors at night.(23)

Despite study shows that 86.3% of the respondents believed that environmental sanitation is one of the most methods of malaria prevention in the study area , there was a very low practicing of environmental management targeting to malaria prevention ,majority 60% of the households mentioned only once per year , environmental management campaign performed in the area. And 73.3 % of the households mentioned collecting potential breeding materials were the most practiced method of environmental management.

Majority of the participant from FDG believed that the main reason of increasing malaria since the last three years was due to very poor practice in prevention of malaria like; no use of bed net, sleeping under bed net after bite by mosquitoes, creating artificial breeding habitat in the households (barrels, concrete containers, pots, tires e.t.c) ,weak environmental managements targeted to malaria prevention(draining, leveling, filling, covering water containers mosquitoes breeding habitats. similarly ,Findings from participant FDG in urban and peri-urban areas of Guatemala suggest, higher collective efficacy perceived to take these actions at the household-level, whereas at the community level often municipal and community cooperation is necessary for successful implementation. This can be a demotivating factor for people who do not see action by their fellow community members or municipal leaders. Therefore, it may be most productive to prioritize household level implementation of the intervention over community level removal of tires and discarded containers. (24)

Conclusion

Even though Anopheles mosquitoes have some breeding preference, they are adapting to breed in different breeding habitats. The new emerging malaria vector, An. stephensi is distributed almost throughout the regions of Eritrea. Studies are ongoing to evaluate the potential risk for An. stephensito change the malaria transmission landscape in the study area and the rest of the country. Community participation in all aspects of malaria prevention was unsatisfactory in the study area. Environmental management targeted to malaria prevention was not properly practiced in this community. According to the interviewed respondents and participants from FDG, there were improper LLINs handling and utilization. Therefore is a need to promote people to practice proper handling, utilization of bed net and environmental management throughout the year.

Abbreviations

IRS: Indoor residual spray
LLIN: long lasting impregnated ne
GPS: Geographical positioning system
SSA: Sab Saharan –Africa
FGD; Focus group discussion
SPSS: Statistical package of social science
WHO: World Health Organization.

Authors' Contributions

AMG, AMW and IYS participated in study design, and data collection. AMG was analyzed data. AMG wrote the draft of the manuscript. AMW & IYS critically reviewed the manuscript for intellectual Content. All authors have read and approved the final manuscript.

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Availability of data and materials
The data used and/or analyzed in this study are available from the corresponding author upon reasonable request.

ETHICAL CONSIDERATION
Ethical clearance was obtained from the Ethical approval committee at the zonal and national ministry of health. And when entering to the selected study area permission was obtained from offices of the local government starting from district administration, municipalities and local administrations. On the top of that verbal consent was taken from the head of the households for all activities performing in the households

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