

**The behavior of *Jhum* cultivators living in Chattogram Hill Tracts
districts and its relation with malaria in Bangladesh**

Abstract:**Aims:**

Malaria is caused by infection of red blood cells with protozoan parasites of the genus plasmodium. It is focal disease where children under five years are most vulnerable group and susceptible to malaria. Malaria still occupational disease in Bangladesh especially among *Jhum* cultivators who depends mostly on *the slash and burn* activities during the rainy season. This study unveils the behavior of *Jhum* cultivators and its relation to malaria infection in Bangladesh.

Study design and methodology:

A both quantitative and qualitative method were used for this study. A survey was done in 10 sub-districts of Chattogram Hill Tracts (CHT) resulting 384 sample sizes considering high nonresponse rate in CHT. A qualitative study like focus group discussion was held in each sub-district to get in-depth view of *Jhum* cultivator related to malaria.

Results:

In this study, total 386 (80.42%) people were *Jhum* cultivators followed by non- *Jhum* cultivators 94 (19.58%). Mean age of people was 39.5 years. *Jhum* cultivators were 2.5 times of risk of malaria infection than other occupations (P -value = 0.046, CI =1.018-6.156). During their stay at *Jhum* sites, 54 % of *Jhum* cultivators hang net in the evening and 44.2% of people did it in sleeping time. The most biting time at *Jhum* sites was 19.00-20.00 h (P -value = 0.011). 71.18% of the *Jhum* cultivators developed malaria after they back home while 26.27% people develop to malaria during working at *Jhum* sites. In logistic regression, distance (OR=1.20, P -value =0.000, CI=1.093-1.316) is most important factor while using of LLIN at *Jhum* sites (OR=0.265, P -value =0.000, CI=0.162-0.431) the other notable factor behind infection of malaria by mosquitos.

Conclusion:

Malaria is still occupational disease especially among *Jhum* cultivators and needs to be taken a comprehensive awareness programme for using of LLIN at *Jhum* sites especially in 19.00-20.00 hours.

Key words:

Malaria, CHT, *Jhum* cultivators and LLIN

Introduction :

Malaria is caused by infection of red blood cells with protozoan parasites of the genus plasmodium. It is one of major fatal diseases in Africa. In 2015, 92% of malaria deaths worldwide were occurred in African Region followed by South East-Asian Region (6%) and then the WHO Eastern Mediterranean Region (2%) [1]. Children under five years are most vulnerable group and susceptible to malaria infection. In Africa, about 285 000 children died before their fifth birthdays in 2016 [2].

Bangladesh, a country in South-East Region, is malaria endemic with 13 out of 64 districts are endemic. The country's endimicity is stratified in three regions--High, medium and low. High endemic districts--Rangmati, Bandarban and Kahgrachari--the three districts of Chattogram Hill Tracts (CHT) bears 84% of malaria cases in Bangladesh [3]. The other endemic districts mostly medium and low endemic districts which covered with plain and hilly areas, are experienced a rapid malaria fall out since 2010 [3]. The CHT districts which has border with India and Myanmar is characteristic with high hill with difficult terrain, inaccessible foothill and deadly vector which is available in densely and fringe forest are the major factors behind high prevalence of malaria in Bangladesh.

BRAC, a leading development organization in world, has been secured grant from the Global Fund along with National Malaria Elimination Programme (NMEP) since 2007 and malaria has dramatically reduced since then. Malaria positivity decreased from 84,690 in 2008 to 29,247 in 2017 and Annual Parasite Incidence (API) also reduced from 7.77 in 2008 to 2.20 in 2017 with malaria mortality rate reduced to less than 1 (0.098) in 100000 population in 2017 [3,4]. The prevalence of *Plasmodium falciparum* and *Plasmodium vivax* and mixed infection are observed 84%, 9% and 7% respectively [3]. Though malaria decreased rapidly in Bangladesh, still Chattogram Hill Tracts (CHT) are major source of malaria morbidity and mortality in Bangladesh.

The tribal people are predominately focused person in CHT districts along with Bengali people living in remote and forested areas dependent highly on *Jhum* cultivation, wood cutting (forest areas), daily labour and other agriculture practices. Of them, *Jhum* cultivator and forest goers are the notable contributing factor of malaria infection in Bangladesh.

Jhum cultivation known as slash –and -burn agriculture, a kind of swidden or shifting cultivation in hilly areas of Chattogram Hill Tracts of Bangladesh has been recognized as subsistence food production system for tribal people. It is still being widely practiced in hilly areas of Bangladesh and considered as the major source of livelihood for tribal people [5,6]. This system involves cutting back and clearing large areas of the hillside through fire and then sowing a variety of seeds in early days of rainy session, preferably April to May. In harvesting period, September to November, *Jhum* cultivators like to go the field with family member to harvest the crop as early as possible. This shifting cultivation, a substance firming system is also practicing globally especially in Asia, Africa and Latin America.

As there is very short study occurred related to *Jhum* cultivation and malaria, BRAC conducted a large scale survey in 10 sub-districts of CHT districts using both quantitative and qualitative method to get the behavioral practice of *Jhum* cultivators and to find whether there is any relationship between *Jhum* cultivation and malaria incidence in Bangladesh.

Material and methods:

Both quantitative and qualitative method were applied under this study. A survey under quantitative study was carried out in Chattogram Hill Tracts. Under this study, sample size was calculated with 5% margin of error with 95% confidence of interval and by assuming 50% households of CHT districts have one *Jhum* cultivator resulting 384 sample size. To minimize high non- response rate in CHT, we added 25% to the sample size and then rounded up that finally the sample size was 480.

The survey was based on two-stage cluster sampling. First we selected 10 sub-districts randomly from 17 sub-districts of two CHT districts--Bandarban and Rangamati--and then selected 3 paras/villages randomly from each sub-district which resulted 30 paras/villages selected under this study. Total 16 households was taken from each para/village under cluster sampling considering their culture of living as a small group in CHT areas. If any para has less than required household then neighboring para was selected for completing the survey. Information from the Bangladesh Bureau of Statistics was utilized to obtain the sampling frame for selection of the para/village in each district. Khagrachari district of Chattogram Hill Tract was excluded in the study considering very few *Jhum* cultivators available in district. All population above the age of five year irrespective of sex, religion, ethnicity in a cluster was eligible to participate in the study. The survey was conducted in November, 2016 and analyzed by STATA 12.

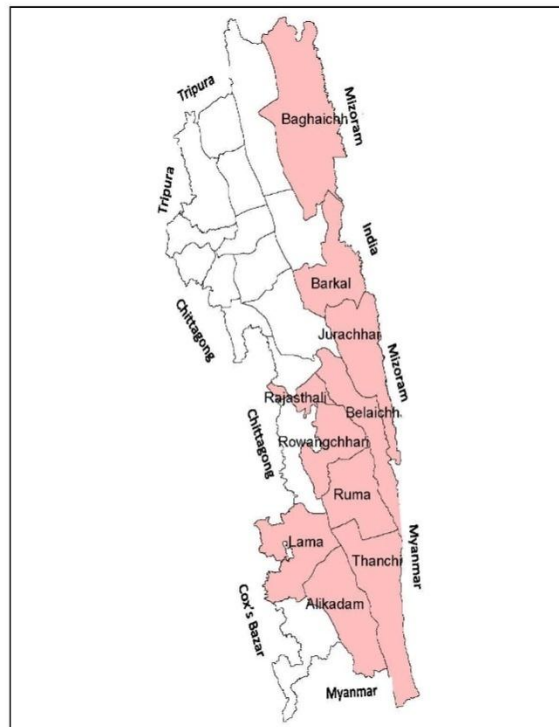


Figure 1: Survey areas

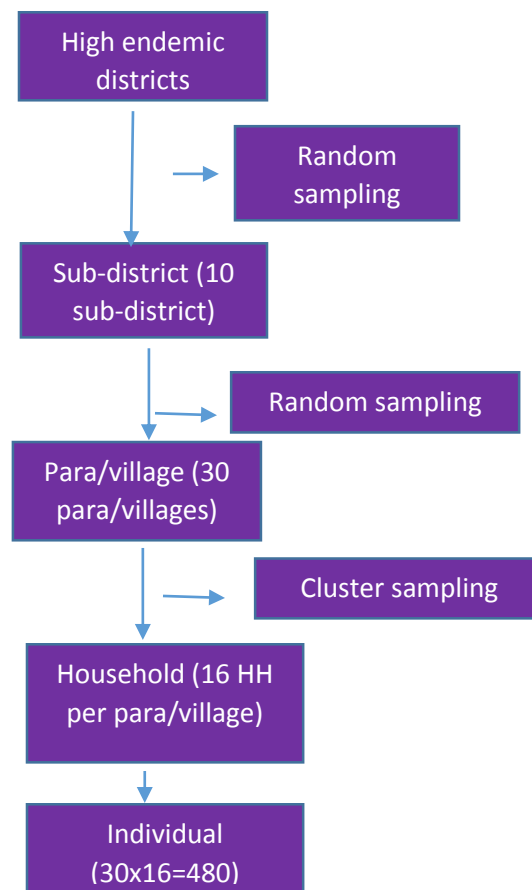


Figure 2: Sampling method and technique

Qualitative study:

Qualitative study like focus group discussion was also done to get in depth information from *Jhum* cultivators. That include whether and how long they need to stay at the field of *Jhum* cultivation, their willingness and practice to hang LLIN at *Jhum* sites, ways to increase use of LLIN at *Jhum* sites. The outcome of FGD was to design a village map delineating the household with *Jhum* cultivator and the malaria patient within the community. One para or village under one sub-district was selected for FGD that implies 10 FGD were done under this study.

Results:

Total 480 samples were studied under 10 sub-districts. Total 386 (80.42%) people were *Jhum* cultivator followed by other occupations 57 (11.88%) and then other cultivators 37 (7.71%). Under the study, Chakma (28.5%) are highest tribal people followed by Marma (18.4%) and then Tripura (15.7%) (Table 1).

Table 1 : Basic information

Occupation					P value
Tribal	Jhum Cult	Cultivation	others	Total	
Chakma	117	10	10	137	0.000
Tripura	67	0	4	71	
Marma	51	15	17	83	
Mro	50	3	5	58	
Boam	24	0	2	26	
Tanchanga	54	0	5	59	
NA	23	9	14	46	
Education					0.000
Not at all	209	20	21	250	
Pre-primary	111	12	9	132	
Post -primary	57	5	13	75	
S.S.C	7	0	9	16	
H.s.c	2	0	4	6	
Degree	0	0	1	1	
Age group					0.017
>26	55	7	19	81	
26-41	171	15	21	207	
41-56	113	8	11	132	
56-71	41	7	4	52	
71-81	6	0	2	8	
Total	386	37	57	480	

Mean age of study people was 39.5 years of age (Fig.3). About 43.13% were under 26-41 years of group followed by 41-56 years of group (27.5%) and then (>26) years of age (16.88%). Among the sex, 71.8% were male and 28.12% were female. Of them 32.46% male were infected by malaria and 18.51% female were infected by malaria (OR = 2.11, P -value = 0.002) (Table 2). Among the 10 sub-districts, we found Alikadam sub-district of Bandarban district is most malaria endemic area with 52% patient with malaria followed by Belaichhari sub-district of Rangamati district (45.8%) while Rajasthali and Juraichhari sub-district of Rangamati are least endemic areas under Chattogram Hill Tracts.

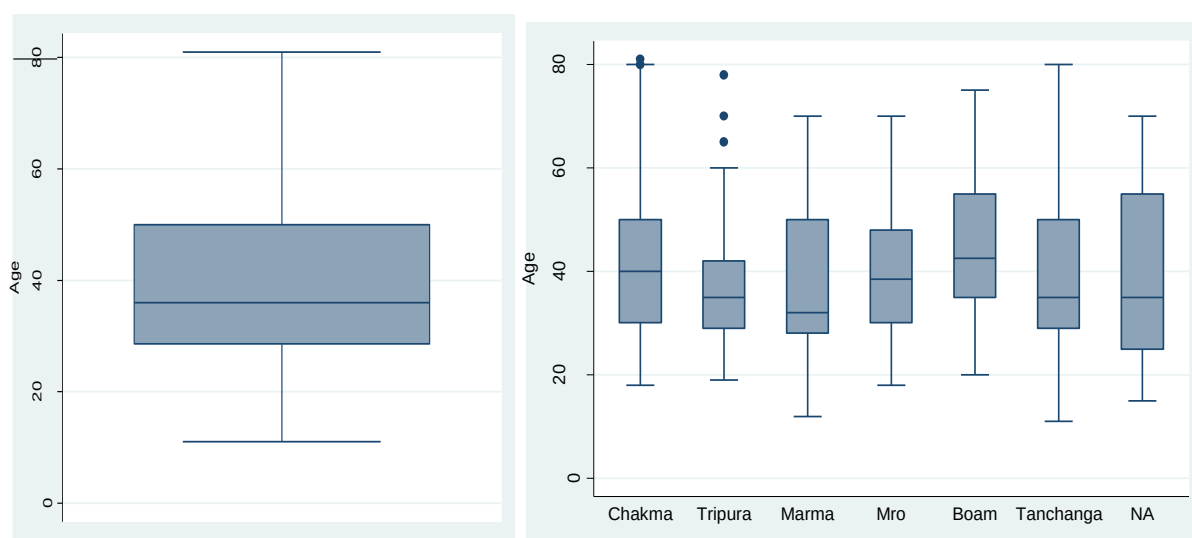


Figure 3 : Boxplot of ages

Table 2: Malaria infection by sex

Malaria in last one year			
Sex	0	1	Total
Male	233	112	345
Female	110	25	135
Total	343	137	480

Among the tribal people, odds of the disease was high in Tripura people (1.2) followed by Boam (0.73) and then Thanchanga (0.51). Bengali was the least affected people by malaria (0.18) in Chattogram Hill Tracts. And this is significant (P -value <0.001) (Table 3).

Table 3: Malaria infection by tribal people

Malaria in last one year			
Tribal	0	1	Total
Chakma	112	25	137
Tripura	32	39	71
Marma	65	18	83
Mro	41	17	58
Boam	15	11	26
Tanchanga	39	20	59
Bengali	39	7	46
Total	343	137	480

Among the occupation of study people, *Jhum* cultivators were infected highly (32.64%) followed by cultivators (16.21%) and then other occupations (8.77%) (Table 4). The Odds Ratio of *Jhum* cultivator is 2.50 (P -value < 0.05 , CI =1.018-6.156) which implies that *Jhum* cultivators is 2.5 times in risk of malaria than other cultivator people. And this is significant (P -value = 0.0001) (Table 5).

Table 4: Malaria infection by Occupation

Malaria in last one year			
Occupation	0	1	Total
Jhum Cultivator	260	126	386
Cultivator(others)	31	6	37
others	52	5	57
Total	343	137	480

Table 5: Logistic regression with Malaria infection and Occupation

Logistic regression	Number of obs	=	480
	LR chi2(2)	=	19.78
	Prob > chi2	=	0.0001
Log likelihood = -277.14634	Pseudo R2	=	0.0345

	V029	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]	
	V075						
	2	2.503846	1.149337	2.00	0.046	1.018314	6.156496
	3	.4967949	.3212521	-1.08	0.279	.1398776	1.764437
	_cons	.1935484	.0863245	-3.68	0.000	.0807505	.46391

During their stay at *Jhum* sites, 54 % of *Jhum* cultivators hang net in the evening and 44.2% of people did it during the sleeping time (Table 6).

Table 6: Timing of hanging of bed net at *Jhum* sites

		Freq.	Percent	Cum.
Evening		98	54.14	54.14
Sleeping		80	44.20	98.34
Others		3	1.66	100.00
Total		181	100.00	

During their stay at *Jhum* sites, 60% people infected by malaria those who hang net within two hours (19.00 h) of evening followed by 45.45% who used net within three hours (20.00 h) and then 32.25% within one hour (18.00 h) of evening. And this is significant (P -value = 0.011) (Table 7).

Table 7: Association between sleeping time and malaria infection

Sleeping time from evening	Malaria in last one year		Total
	0	1	
0	8	0	8
1	21	10	31
2	12	18	30
3	6	5	11
Total	47	33	80

Though prevalence of malaria among *Jhum* cultivator is high, the exposure of malaria is different. Fever of malaria developed highly (71.18%) when they back home which was more than 2.5 times than the symptoms of malaria developed during working (26.27%) at *Jhum* sites (Table 8).

Table 8: Exposure of malaria of *Jhum* cultivators

Timing_of malaria	Freq.	Percent	Cum.
During Jhum	31	26.27	26.27
Return to Home	84	71.19	97.46
One the way	3	2.54	100.00
Total	118	100.00	

The regression line between distance and exposure of days of malaria revealed that most of the exposure happened within 10-15 days and few of them exposed after one month. And it is significant (P value = 0.0135, CI = 0.0197-0.16747) (Figure 4)

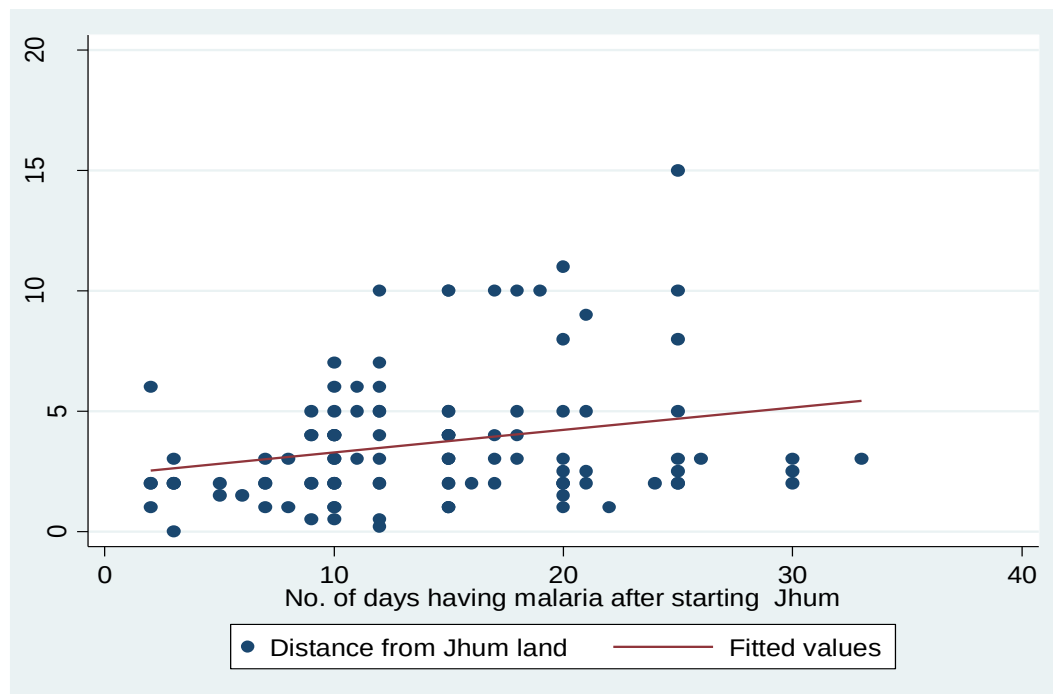


Figure 4: Regression line between distance and exposure of days

If we take logistic regression with malaria in last year, we found the variable with LLIN, distance, and hanging LLIN at *Jhum* sites--the model are fitted significantly (OR: distance =1.2; OR: hanging LLIN: 0.265 (P -value = 0.000)). The Odds Ratio of LLIN (No. 4) is 0.124 tells us that malaria decreases significantly by 12% if we change no. of LLIN from 3 to 4. The Odds Ratio of distance (V041) is 1.20 explain that one unit of change of distance increases risk of malaria by 1.2 times and the Odds Ratio of LLIN hanging at *Jhum* sites (V045) is 0.265 tells us that malaria decreases significantly by 26% for each unit of positive change of using of LLIN at *Jhum* sites (Table 9).

Table 9: Logistic regression of multivariate variables

Logistic regression	Number of obs	=	388
	LR chi2(6)	=	53.18
	Prob > chi2	=	0.0000
Log likelihood = -214.19429	Pseudo R2	=	0.1104

V029	Odds Ratio	Std. Err.	z	P> z	[95% Conf. Interval]		
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V024							
1	.2525105	.1933396	-1.80	0.072	.0563041	1.132449	
2	.1941317	.1401586	-2.27	0.023	.0471572	.7991796	
3	.2528257	.1928998	-1.80	0.072	.0566729	1.127891	
4	.1248502	.1222236	-2.13	0.034	.0183272	.8505176	
V041	1.200004	.0567957	3.85	0.000	1.093694	1.316649	
2.V045	.2651453	.0658626	-5.34	0.000	.162946	.4314437	
cons	2.24276	1.609671	1.13	0.260	.5493627	9.156011	

The qualitative results addressing the practice of using of LLIN at *Jhum* sites which are summarized in table. In focus group discussion, most of the member opined they should stay at *Jhum* sites for several days but sometime they could not bring the LLIN. If they carry it, they hung it along the pole of temporary shelter. At the final stage, a mapping was done to indicate their household and the patient's house.

Table 10: Summary of qualitative findings on using of LLIN in *Jhum* cultivation

Hypothesized mechanism	Results
1. Whether Jhum cultivator need to stay at <i>Jhum</i> sites	Jhum cultivators should stay at <i>Jhum</i> sites. It depends on distance. If it is 2-3 km away from their home, they like to back home in evening.
2. Whether LLIN hung during the Jhum cultivation	Most of the people do not use LLIN during Jhum cultivation. If people are aware, they bring LLIN from their home. Sometime LLIN could not cover the family. Sometime they sleep without the net.
3. Ways and how to use LLIN during Jhum cultivation	Usually they hang the LLIN during sleeping time, if they brings it from home. They tied the LLIN along the pole of temporary house. We need to more awareness to bring LLIN and using it <i>Jhum</i> sites

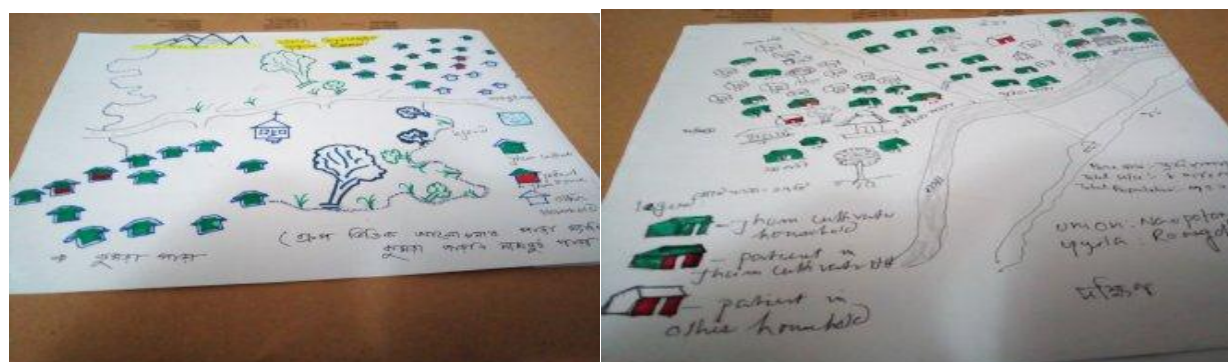


Figure 5: Community based mapping after Focus group discussion

Discussion:

Bangladesh has been experiencing a rapid malaria cases fall out since 2008 with a sudden malaria upsurge in 2014 [3]. But this is not the case in Chattogram Hill Tracts (CHT) which is still contribute 93% of malaria cases in Bangladesh [4]. The deep forest, difficult terrain and inaccessible foothill along with diverse occupation of the tribal people render a causal effect for high incidence of malaria in CHT of Bangladesh. In this study, *Jhum* cultivation alone came as a greater risk of malaria infection (OR=2.5, P -value <0.05) in CHT where 80% people of tribal population cultivate this *slas-burn* activity in rainy session. The result shows that 54.61% people of *Jhum* cultivators are not access to school which is real concern for Chattogram Hill Parisad (P -value <0.001). Education holds the key to a sustainable response to malaria. The probability of dying from malaria is inversely related to income and education [7]. A clustering of risk factors, including low education increases people's vulnerability to malaria and may be as important as the exposure itself [8]. This makes quality schooling and socioeconomic development are the critical components of the global effort to defeat the disease [9]. To complement this, BRAC malaria programme initiate participatory malaria education at school level since 2016.

The study shows that the sub-district, Alikadam of Bandarban district is the most high burden sub-district in Bangladesh with 52% of people inflicted with malaria followed by Belaichhari sub-district (45.8%) of Rangamati. Kuruppata and Farua union of Alikadam and Belaichhari sub-district, the two border unions with Myanmar and India, comes as the most-high endemic Union in Bangladesh. The unions are inhabited mostly by *Jhum* cultivators with 89.5% in Farua and 83% in Kuruppata and this is significant (P -value <0.001). Among the people, male (32.46%) were more affected with malaria (more than 2 times) than female (18.51%) (P -value <0.01) [3]. *Jhum* cultivation, the mix crop cultivation which is dominated by male member is more exposure to malaria than female. In tribal community, women are involved in *Jhum* cultivation but they are significantly less at risk of malaria infection [10]. This is because women go to sleep earlier with children while men like to sit outside in a shop or an around a fire for a while before retire to bed.

Considering that *An. dirus* bites early and is a highly anthropophilic and exophagic vector, men are obviously more exposed than women.

The result shows that LLIN have been covered systemically in CHT areas. The country follows 100% LLIN coverage in CHT in line with 1.8 population @LLIN following National Malaria Strategic plan (2017-2021) [11]. Though this aggressive LLIN distribution, our study found 2.7% people do not have LLIN during the survey period. This might be happened as Chattogram Hill Tracts are always facing migrate people from plain land and also tribal people sometimes replace their homestead to securing the livelihood. But the more growing concern is 44% people at *Jhum* sites like to hang the net during the sleeping time and 41.25% people were inflicted by malaria and this is significant (P -value <0.01). This is consistent with most biting period of vector (19.00-20.00 h) with the peak of 19.00 h. The revelation is congruent with finding of Ziway Central Ethiopia, which observed that the Peak indoor and outdoor activities of *An. Arabiensis* was the early period of the night, between 18:00–19:00 and 19:00–20:00h while Peak indoor and outdoor activities of *An. pharoensis* occurred between 20:00–21:00 and 19:00–20:00h respectively [12]. *Jhum* cultivators still come as major factor for malaria infection in Chattogram Hill Tracts. In the logistic regression with multiple variables like distance, LLIN and hanging of LLIN at *Jhum* sites, we found distance is critical factor for *Jhum* cultivation which implies that one unit of positive change of distance increases risk of malaria by 1.2 times. If distance of *Jhum* sites from household is 2-3 km, they will back the household in the evening and there is no point of risk of malaria infection. The other important factor is hanging LLIN which refers risk of malaria will decrease by 26% for each unit of positive changes of using LLIN at *Jhum* sites. The result is of complement and consistent with qualitative findings. People seldom use LLIN at *Jhum* sites, if they bring it and most of the time they could not hung it. People like to go to *Jhum* sites with family member and LLIN do not cover the whole family. Sometimes it is difficult to hang LLIN in temporary household or shelter which discourages them to using the LLIN. This is coherent with our findings that 26% of *Jhum* cultivators were affected by malaria during *Jhum* cultivation. The result of Central

Vietnam is also congruent to the findings where regular working and sleeping in the forest was a strong risk-factor with the odds almost three times higher than that of people not working in the forest. Even occasional forest work was a significant risk-factor for malaria (Adjusted OR = 1.48; 95%CI [1.01; 2.17] [10].

Jhum cultivators are often works in large group including the family member at several phases of cultivation exposed by malaria during the cultivation at *Jhum* sites. The risk of malaria is high when it is exposed during the cultivated days and it will turn severe if they do not seek treatment within the day or two. *P. falciparum* malaria may be fatal if the treatment is delayed beyond 24 h after the onset of clinical symptoms [13]. The result shows that the exposure of malaria is high among the people who back home (71%) than the people being cultivated (26.27%) at *Jhum* sites. The fact is, *Jhum* cultivators like to stay at *Jhum* sites for 5-7 days, it is difficult for them to seek treatment during their stay at *Jhum* sites and most of them back immediately whenever they feel fever. Usually malaria exposed in 10-15 days after biting by mosquitoes and the incubation period of *P. falciparum* is 7-10 days depending on their immunity [13]. This implies the treatment of *Jhum* cultivators occurred sometimes in delays as the health facility or service provider is not within his/her walking range. Household located more than 3 km from a health facility is more likely to delay seeking malaria treatment. The study in Myanmar and on the Thai–Cambodian border found that malaria treatment was often delayed in remote areas [14].

The results of this study are in agreement with several other studies that show that agricultural practices may affect an individual's risk of malaria infection. Agricultural practices have been previously implicated as an occupational risk factor for malaria infection in other settings, including palm oil plantations in Papua New Guinea, irrigated rice paddies in Ethiopia and Cote d'Ivoire, and forest settings in Vietnam [15,16]. In one study, agricultural irrigation was associated with greater abundance of anopheline vectors in rural Tanzania [17]. In contrast, one study in Peru found that agricultural practices were statistically associated with lower malaria incidence rates [18]. These studies show that a specific agricultural practice may impact malaria transmission,

depending on the ecology of local anopheline vectors and the nature of the agricultural practice. Furthermore, several studies in Asia have observed increases in malaria vectors after deforestation, conceivably because it allows surface water accumulation at cleared sites. Although these studies looked at large-scale general deforestation, the same mechanism may apply at *Jhum* sites after the removal of the jungle [19].

It is fact that the abundance of mosquitoes at *Jhum* sites leads to higher rates of infection among *Jhum* cultivators. Usually *Jhum* cultivator cultivate their land in remote places which is locked of hilly sites with jungles and inaccessible foothill, a fitting environment for malaria breeding in CHT areas. Topologically, the CHT districts vary from other regions of the country being typified by ranges of forested hills and associated valleys with rivers and small lakes [20] that provide abundant oviposition sites for potential vector species. The study of ICCDR'B found the abundance of diversified *Anopheles* vector in remote areas of Matiranga sub-district of Khagrachari district where malaria infection in 1000 population is less than one. *An. Philippinensis*, *An. Nivipes*, *An. Minimus*, *An Vagus* are found profoundly in Matiranga Sub-district which is surrounded by plain and hilly areas that is adjacent to Bangladesh and India boarder [21]. Malaria species began to increase in May and reaches highest in August and lowest in February [3]--the phenomena coincide with phases of *Jhum* cultivation from preparation of *Jhum* sites (May-June) to harvesting period (November). Another study done by ICCDR'B in a Union of Bandarban Sadar in 2009, found abundance of diversified vector--*An. Philippinensis*, *An minimus*, *An Vagus*, *An. Jeyporiensis*, *An. Kochi* in Khohalong union of Bandarban district. Three species were nearly co-dominant. *An. jeyporiensis* (18.9%) was the most commonly captured species, followed by *An. vagus* (16.8%) and *An. kochi* (14.4%). The highest diversity of species was found in July and lowest in September and April.

Though this study cover more than 50% sub-districts of Rangmati and Bandarban hill districts , it is left Khagrachari district where diversified cultivation are prevailing apart from *Jhum* cultivation, we could not generalize the findings for Chattogram Hill Tracts. In addition, an entomological

study also needed to conclude whether *Jhum* cultivation contribute to develop a breeding site for mosquitoes that only intensify mosquito biting on *Jhum* cultivators.

With this study, we conclude that though *Jhum* cultivation is a major contributor of malaria infection in Bangladesh, we still could not reach them to mitigate this. The behavior of *Jhum* cultivator is need to change to take early bed to interrupt malaria transmission at household as well as in community level. Using LLIN at *Jhum* sites need to be utmost priority in a bid to reduction of malaria and thus enable Bangladesh to achieve malaria elimination in near future.

Conclusion:

The study confirms there is high malaria morbidity in CHT areas where a major portion of malaria is transmitted through *Jhum* cultivators. A comprehensive awareness programme is needed to change the behavior of *Jhum* cultivators in using LLIN both at home and *Jhum* sites. Early to bed and sleeping under LLIN at *Jhum* sites is the best way to reduce malaria in Chattogram Hill Tracts which will foster malaria elimination in Bangladesh.

Consent:

All participants involved in survey were taken written consent before the interview. The consent form are kept in proper custody as confidential.

Ethical approval:

As there was no risk of health hazard like testing of RDT and we recorded the malaria cases based on participants response where all people filled the consent form before the interview, ethical approval was not deemed considered important for this study.

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