Domestic Prevalence of Malaria Vectors and Self-reported Malaria Episode with Respect to Ownership and Utilization of Long-lasting Insecticidal Nets in Selected Resettlement and Indigenous Villages in Sasiga District, Western Ethiopia

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Abstract
Agricultural resettlement of none-immune population in malaria endemic lowlands has become one of the key challenges to malaria control and elimination efforts in Ethiopia. Long-lasting insecticidal nets (LLINs) are currently the best malaria control intervention in the country. We assessed indoor prevalence of malaria vectors and the disease incident with respect to possession and utilization of LLINs in selected resettlement and indigenous villages in Sasiga district, western Ethiopia. Adult mosquitoes were monitored indoors and outdoors from randomly selected samples of 12 houses using Centers for Disease Control and Prevention light traps (CDC-LTs). Whereas LLINs possession and utilization survey was conducted concurrently with household survey of self-reported malaria episode. The study was conducted once during dry season (December-February), minor malaria transmission season (March-May) and the major transmission season (September-December) in 2011-2012. Data were analysed using One-way analysis of variance, logistic regression (odd ratio) and descriptive statistics via SPSS version 20.0. The results were considered significant at $P < 0.05$. *Anopheles gambiae* s.l. constituted 81.1% (n=270) of the anopheline collection and the rest 18.9% (n=63) were *Anopheles coustani* and *Anopheles cinereus*. The mean indoor density of the malaia vector, *An. gambiae* s.l. was higher in the resettled than the indigenous village. The overall coverage and utilization rate for at least one LLIN per household was 62.2% and 62.0% for the indigenous but 72.8% and 72.2% for the resettled village, respectively. Average prevalence of self-reported malaria episode per household in the villages were 31.1% and 41.1% for the indigenous and the resettled villages in that order. Logistic regression revealed that use of nets for other purposes, saving nets for future use and possession of radio had significant association with net ownership and utilization in the surveyed households. Indoor malaria vector and the disease prevalence tend to increase in the resettled village than the indigenous village regardless of significantly higher net ownership and utilization in the former village. Therefore, the impact of housing, insecticide resistance and feeding behavior of the target vectors need to be monitored as they might impact on protective efficacy of LLINs.
Keywords: Ethiopia, long-lasting insecticidal nets, self-reported malaria episode, resettlement

1. Introduction

Malaria is endemic in various parts of Ethiopia with mainly unstable and seasonal transmission [1] that peaks bi-annually from September-December and April-May coinciding with major and minor rainy seasons respectively [2]. *Anopheles arabiensis* is the major malaria vector in Ethiopia [3]. *Plasmodium falciparum* (60%) and *Plasmodium vivax* (40%) are the predominant human malaria parasites in the country [4].

Because of population pressure and degradation of natural resources in Ethiopian highlands, high altitudinal mobility and agricultural resettlement of none-immune population in malaria endemic lowlands has become a key challenge that exacerbate malaria transmission and hurdle malaria control efforts in the country [4,5]. Resettlement is the phenomenon of population redistribution, either planned or "spontaneous" into new sites called resettlement sites or schemes [6]**.** It can result in ecological changes due to human actions such as deforestation and establishment of new settlements in previously unsettled areas and consequently allow for the proliferation of mosquitoes that prefer human habitation to natural settings [7]. During 1984-86, state-sponsored resettlement program resettled some 600,000 people mostly in the lowlands of western Ethiopia [8]. Nevertheless, the programs resulted in considerable health problems to the resettlers mainly due to malaria and diarrhea [9]. The most recent resettlement program started in 2003 has also resulted in the immigration of non-immune populations into new malarious areas [5]. To the best of our knowledge, published evidence concerning the level of malaria transmission and vector control efforts in these agricultural resettlement villages in Ethiopia are lacking. The most recent study on the impact of urban resettlement on malaria incidence and entomological indices showed higher mosquito load and malaria transmission intensity in the resettlement village compared to non-resettlement village [10]. These evidence suggest that special attention and action should be given to resettled communities in malaria endemic parts of the country. The present study focused on agricultural resettlement villages unlike the previous study.

Resettlement villages in malaria endemic lowlands are priority target areas in malaria control efforts and rely on long-lasting insecticidal nets (LLINs) to reduce indoor human exposure to mosquitoes. LLINs reduce domestic vector density by killing or repelling mosquitoes and hence suppress malaria transmission at household level [11]. Increases in the coverage of long-lasting insecticidal nets (LLINs) have significantly reduced the abundance of endophilic malaria vector species such as *Anopheles gambiae* in Africa [12]. The Ethiopian Federal Ministry of Health through donor support has been distributing LLINs to malaria-affected areas since the end of August 2005. The Ministry aimed at covering 100% of households with at least one LLIN per sleeping place and at least 80% LLINs use during 2011-2015 [1].

Moreover, majority of the peripheral communities cannot easily access healthy laboratory facilities which are limited to health centers and hospitals in Ethiopia. The lack of access to laboratory facilities coupled with economic barriers imposes peripheral communities to manage malaria by self-treatment after self-diagnosis at home [13]. Peripheral health facilities, particularly Health Posts prevent malaria primarily by LLINs and rely on clinical signs and rapid diagnostic tests (RDTs) for treatment. However, evidence on the density of indoor malaria vectors and prevalence of self-reported malaria with respect to the operational use of LLINs were lacking in these rural agricultural settings. This paper was aimed at assessing the density of malaria vectors and prevalence of self-reported malaria episode in comparison with level of LLINs coverage and use in one resettlement and one indigenous village in western Ethiopia.

1.1. Materials and methods

1.1.1.The study area

Community based cross sectional household survey was conducted during dry, minor and major malaria transmission seasons between December 2011 to December 2012 in two malaria endemic villages in Sasiga district, western Ethiopia (Figure 1). Sasiga district was purposely selected because it is major malaria prone areas in the western Ethiopia and is composed of indigenous and resettlement villages. Among the malarious villages of Sasiga district, Karsa Mojo (KM) and Mada Jalala (MJ) were purposely selected due to their proximity to potential malaria mosquito breeding sites as well as accessibility of the information and knowledge about malaria cases.

Karsa Mojo is located at 9° 22′N, 36° 10′E adjacent to MJ to the west. There were about 400 household heads inhabiting the village in 2012. The village is one of the pioneers in the district and predates the establishment of MJ. Whereas, MJ is a recently resettled village located at 9° 14′N, 36° 27′E. There were about 600 household heads in the village in 2012. Both villages situate in lowland savanna of western Ethiopia in a Blue Nile sub-Basin where malaria is endemic.

Topography of the study area is relatively flat, with the natural vegetation mainly of riverside forests dominated by indigenous trees and savanna vegetation. Its elevation averages about 1350 metres above sea level. Annual rain and relative humidity for nine consecutive years (2002_2010) averages about 93.35cm and 75.5% respectively. In the years of 2002-2010, minimum mean and maximum annual temperature was 11.2, 20.1 and 29.1^{0}C respectively (Source: National Meteorological Service Agency of Ethiopia, Unpublished data). Many of the inhabitants typically lives in traditional African grass-thatched houses locally known as 'mana chita'. However, the design and size of the houses differ between the two villages. Houses in the resettled village (MJ) were uniformly small grass-thatched huts, where as houses in the native village (KM) were larger in size with either iron sheet or grass-thatched. The inhabitants could not easily access to health facilities. There was one health post operating in each villages and malaria control by Health Extension Workers (HEW) in the villages relied mainly on LLINs. Diagonsing treating the cases with anti-malarial drugs was mainly based on RDTs as well as the patient's clinical signs and symptoms. Home management of malaria, i.e., self-treatment with traditional and modern medicine, after self-diagnosis, based on clinical symptoms was common practice during malaria seasons.

1.1.2. Mosquito collections

Samples of adult mosquitoes were collected from 12 randomly selected houses (six per village) coinciding with the household LLINs surveys. The 12 houses were fixed for the mosquito sampling carried out once during the dry (December-February), minor malaria transmission (March-May) and major transmission season (September-December) in 2011-2012.

In each house, one CDC light trap (New Standard Miniature Light Traps 512 6 V 150A; John W. Hock, Gainesville, FL) was placed indoor about 45cm above sleeping persons, who were protected by mosquito nets. Another trap was placed outdoor close to the outer wall under the roof of the house. The light traps operated all night from 18:00 to 06:00 hours. Next day the mosquitoes were collected from the traps, kept separately in labeled paper cups and stored on silica gel for later species identification. Adult mosquito identification was based on identification keys [14, 15] at Addis Ababa University Insect Pathogen Laboratory.

1.1.3. Household survey for LLINs possession and utilization

For the household LLINs and self-reported malaria episode survey, a (house) census was carried out to estimate the total number of houses per village. Then, 15% of household heads were randomly selected using systematic random sampling and surveyed. The decision on the 15% was made based on accessibility of the houses of these peripheral communities and hence to reduce costs of the project. Thus, every 10th house was randomly selected from MJ because the houses are densely located, whereas every 7th house was selected from KM as the houses are more sparsely located. Sample sizes were proportional to the number of households per village. Sampling was started from the most peripheral house in the village and continued until 57 and 60 households heads were surveyed from KM and MJ respectively.

Insecticidal net ownership, utilization of the nets and factors determining (or affecting) the use of the nets were surveyed. Direct observation (visual inspection) and interviewer-administered questionnaire were used for data collection. The observation was carried out early in the morning at 5:00-6: am [16] to inspect the occurrence of bed nets over sleeping places, the number of bed nets used, the number of family members sleeping under the net (s), the condition of bed nets (damaged or undamaged).

1.1.4. Household and health facility survey for malaria episodes

The self-reported malaria episode survey was carried out concurrently with the LLINs survey to record household characteristics, self-reported malaria episodes, days lost due to malaria and the use of preventive measures. Questionnaires were addressed to the mother in the household as she was expected to best know the health history of the household members. In case the mother was not at home, the father in the household was employed. Household members of 18 years and older were asked to recall the number of malaria episodes over the last 3 months and the number of days lost due to illness. Concerning children under 18 years of age, data were obtained from the mother. To be able to better assess whether illness episodes reported were really due to malaria, the respondents were asked for the symptoms and also medication results, in case they had used health care services.

Symptoms that were used to classify episodes as malaria were fever in the last two days, headache, sweating, chills and loss of appetite [17]. In addition, the type of medication the person had taken to cure the illness was asked. Based on the information given the interviewer decided if an episode has to be classified as malaria. The same interviewer carried out the work in both villages to reduce possible inter-observer bias.

1.1.5. Data analysis

Data were analyzed using IBM SPSS statistics version 20.0. Indoor and outdoor mosquito densities were calculated as mean number of mosquitoes per species per CDC light trap per night. These densities were used to compare the prevalence of *Anopheles* malaria vectors between the villages. Differences in the mosquito density and net utilization between villages and across seasons were analyzed using one way analysis of variance (ANOVA). The seasonal LLINs possession and utilization and prevalence of self-reported malaria episode were computed using descriptive statistics. Logistic regression (odds ratio) was used to analyze the key variables associated with the net utilization and prevalence of malaria episode at the household level. The key variables were use of nets for other purpose, saving net for future use, possession of radio and malaria transmission seasons. Results were considered significant at $P < 0.05$.

1.2. Results

1.2.1. Mosquito species composition and prevalence

Altogether 333 female anophelines were collected, out of which 81.1% (n= 270) were *An. gambiae s. l.* and 18.9% (n=63) were *Anopheles coustani* and *Anopheles cinereus* (Table 1). *Anopheles gambiae s. l.* was the dominant species in both villages, KM (41.1%; n=137) and MJ (40%; n=133). Most mosquitoes (62.2%; n=207) were captured during the major malaria transmission season and only a few (3.6%; n=12) during the dry season. Because *An. coustani* and *An. cinereus* were rare in both villages and these speces have not been incriminated as malaria vectors in the country so far, further result and discussion sections of the present article focus on the primary malaria vector i. e., *An. gambiae* s.l. The *An. gambiae* s.l. collected in this study is most probably *An. arabiensis* because, *An. arabiensis* is the sole primary malaria vector species belonging to *An. gambiae* s.l. in Ethiopia.

Domestic host-seeking density of *An. gambiae* s.l. significantly varied among the seasons (df = 2, F = 17.4, $P < 0.001$) and Tukey Honestly Significantly Difference (HSD) test revealed that the indoor density of *An. gambiae* s.l. was significantly higher during the major malaria transmission season than during the other seasons. The indoor density of *An. gambiae* s.l. was higher in MJ than KM. However, its outdoor density was higher in KM than MJ (Figure 2).

1.2.2. LLINs possession and utilization by households

Table 2 shows the LLINs possession and utilization in households in the indigenous and resettlement villages. Overall, 237 households owned at least one bed net (67.5%; 95% CI 62.4_72.4%). In KM and MJ 106 (62.0%) and 131 (72.8%) households owned at least one mosquito net, respectively, and the difference was statistically significant [OR (95% CI) = 0.610 (0.389-0.957)].

Altogether 115 (32.1%) of the households had no bed nets, 183 (52.1%) of the households owned single bed nets, and 53 (15.1%) of the households possessed more than one bed nets. In KM, 81 (47.4%) and 25

(14.6%) households owned one and more than one bed nets respectively. In MJ, 102 (56.7%) and 28 (15.6%) households owned one and more than one LLIN, respectively. Households that had nets, had obtained them from the district health post free of charge.

In both villages the overall reported bed net use for at least one LLIN the night prior to the household survey was 236 (67.2%; 95% CI 62.1-72.6%). In KM and MJ 106 (62.0%) and 130 (72.2%) of households were reported to use at least one LLIN respectively. In KM the reported number of households that used at least one LLIN was significantly different [OR (95% CI) = 0.672 (0.400-0.983)] compared to MJ. In total 148 (42.2%) and five (1.4%) of households were observed to use one LLIN and more than one LLINs in the villages respectively. In KM 75 (43.9%) and two (1.2%) of households were observed to use one and more than one bed nets respectively unlike in MJ that were observed to use 73 (40.6%) and three (1.7%) respectively.

From the total household survey in the villages, 225 (64.1%) reported that they obtained the nets before six months ago while 12 (3.4%) households reported they got the nets less than six months ago. In KM and MJ 101 (59.1%) and 124 (68.9%) of the households were reported to obtain the nets before six months ago respectively. Furthermore, seasonal LLINs ownership [OR (95% CI) =1.829 (1.042-3.209)] and utilization [OR (95% CI) = 1.748 (1.000-3.056)] were significantly different between the study villages.

1.2.3. Determinants of LLINs ownership and utilization in the villages

Logistic regression (odds ratio) revealed that use of nets for other purpose, saving net for future use, possession of radio and seasons of the year were significant predictors of mosquito net ownership by households (Table 3). Of these variables season of the year showed strong positive association with mosquito net ownership but the others showed significant negative association with net ownership.

Similarly, the study villages, use of nets for other purposes, saving nets for future use and presence of radio in the households were negatively associated with net utilization in the surveyed households. However, age of the household heads and seasonality were found to strongly increase the odds of net utilization by households (Table 4).

1.2.4. Seasonal prevalence of self-reported malaria episode

Table 5 shows self-reported malaria episode and number of days lost due to malaria in the surveyed households. The overall proportion of reported malaria episode per household in the villages three months prior the study was 127 (36.2%, 95% CI 31.3-41.3%). In KM and MJ malaria episode was reported from 53 (31.1%) and 74 (41.1%) of the households respectively. The difference in self-reported malaria episode between the villages was significant [OR (95% CI) = 0.643(0.415-0.999)]. Among the surveyed households, in 126 (35.89%) households at least one family member had symptoms of malaria over three months prior to the study. Majority (113, 32.2%) of the self-reported malaria patients per household, lost less than seven days due to illness. Net ownership by household [OR (95% CI) = 0.831(0.520-1.330)] and net utilization [OR (95% CI) = 0.863(0.541-1.378)] were inversely associated with self-reported malaria episodes by the households.

1.2.5. Health facility data on malaria prevalence in the study villages

The overall mean number of *P. falciparum* and *P vivax* observed with RDT per month at the local Health Posts of the villages were 8.00 and 16.3 respectively. In KM and MJ the mean monthly prevalence of *P falciparum* were 4.91 and 11.08 respectively. Whereas prevalence of *P vivax* was 14.33 in KM and 17.92 in MJ. Difference in mean number of the malaria parasites between villages per month were not statistically significant (F= 2.783, df= 1, P= 0.109) for *P falciparum* and (F= 0.281, df= 1, P=0.601) for *P vivax*.

1.3. Discussions

Indoor malaria transmission is primarily mediated by *An. arabiensis* (*An. gambiae s.l.*) in Ethiopia. *Anopheles arabiensis* has evolved behavioural adaptations to feed indoors on human more than any other anopheline species in the country and has been targeted for control and elimination from domestic venues. LLINs were designed to significantly reduce abundance of indoor biting malaria vectors and prevent indoor malaria transmission. The results of the present study showed that indoor density of *An. gambiae s.l.* (presumably *An. arabiensis*) collected from the resettled village was high as compared to density of the same species obtained from the indigenous village. This finding is consistent with a recent study by Degefa *et al*. [10] that found higher density of *An. gambiae* s.l. in resettlement villages compared to non-resettlement villages in suburbs of Jimma town, south central Ethiopia. Based on the previous and the present results, it can be suggested that rural and urban resettlement villages located in malaria endemic parts of the country were at higher risk of malaria mosquito load and the disease burden.

The reason for high domestic abundance of *An. gambiae s.l* in the resettled village unlike the indigenous village in the present study might be due to housing differences between the two villages. The houses in the resettlement village were uniformly grass-thatched with unplastered walls that favor entry of host seeking mosquitoes as compared to the indigenous houses which were more diverse composed of corrugated iron sheet roofed and grass thatched and had walls plastered. The impact of housing on indoor malaria vector abundance and transmission worth further studies particularly in settlement villages.

The overall coverage for at least one LLIN per household in the villages found in the present study (67.5%), could be considered low in reference to the most recent national strategic plan for malaria prevention and control in the country [1], which aimed to attain 100% LLINs coverage with one LLIN per sleeping place on average in the years 2011-2015. Results also showed significant difference in the coverage of at least one LLIN by households between the indigenous and the resettlement village. The significantly higher net ownership in the resettlement village as compared to the indigenous village could be explained in terms of the priorities and more attentions given by the government in primary healthcares to the high malaria risk areas particularly the resettlement villages, army and refugee camps in malaria endemic areas. Furthermore, although the current plan is to cover two LLINs per household for every household with family size greater than two in malaria endemic villages [1], the present results indicate that ownership of more than one net per household was yet lower than the target plan in both villages. This implies that there was lack of sufficient nets to cover all household members in both villages.

In reference to the recent national malaria strategic plan of the country 2011-2015 [1], which aimed 80% LLINs use, the LLINs utilization rate found in this study (67.2%) was low. This would be in agreement with prior studies that have recorded lower net utilization by households in the country [18, 19]. However, the net utilization rate that was found in this study is higher than those found in the prior studies which imply that progresses have been made.

On the other hand some studies have reported higher net utilization rate by households as compared to the figure found in this study. For example, Animut *et al*. [20] reported that from 3131 households that were surveyed in malaria prone areas of the country, 81.6% were found to use nets which is higher than 67.2% we found in this study. One possible explanation could be the nature of the study population. The former study was concerned with selected households in malaria prone areas across the country unlike the present study which was limited to households residing in two malaria endemic villages. Furthermore, net utilization rate in the resettled village was significantly higher than in the indigenous village. This would be expected because the indigenous people pre-exist in the study area and are more immune to malaria and might be more adapted to alternative control efforts as compared to the resettlers. In addition, higher net coverage observed in the resettled village might encourage more net use by the resettlers.

Results also revealed that season of the year had strong positive association with mosquito net ownership by households unlike use of nets for other purpose, saving net for future use and possession of radio which were found to have a significant negative association. Strong positive association between malaria season and net ownership by the households would be expected because malaria is seasonal in Ethiopia [2, 4] and net distribution and public sensitivity to malaria is more connected to transmission seasons [1, 17]. Many people do not feel they need to own or use nets in dry season where there may be fewer nuisance mosquitoes as compared to the wet seasons where mosquito density peaks and as a result net utilization is associated with mosquito and malaria season.

However, use of nets for other purpose and saving nets for future use were found to decrease the odds of possessing nets by households. One possible reason for this could be lack of sufficient nets for the villagers regardless of high demand of the inhabitants for the nets which imply that use of nets for other purpose and saving nets for future use by the households were minimal. Likewise possession of radio by households was strongly inversely associated with net ownership by the households. This might have resulted due to free distribution of nets by the local health posts as none of the households were found to obtain nets from elsewhere by themselves. In addition the people might be using alternative methods rather than nets as it was reported based on the same results elsewhere in the country [21].

Moreover, positive association was observed between ages of household heads and net utilization in the study villages. This would be expected because the majority of the surveyed household heads were 25-50 years old and maturity of household heads may positively impact on net utilization through guidance, counseling and monitoring his/her household. Similarly, the positive association between malaria transmission season and net utilization by the households could be due to strong sensitivity of the people about malaria and its protection measures during malaria transmission season of the year [1, 21].

Place of residence was found to decrease the odds of net utilization by the households. This may be due to differential net possession and utilization rate between the villages. Likewise, the negative association among use of nets for other purpose, saving nets for future use and net utilization by households could be due to the explanations given earlier in this discussion. Furthermore, the negative association of possession of radio with utilization of nets could also be explained by the possible exposure to information regarding the alternative methods of preventing mosquito bites as a result of which alternatives other than mosquito nets may be used.

Another aim of the present study was to assess domestic prevalence of self-reported malaria episodes in connection with utilization of LLINs. Results showed that people living in the resettlement village were more affected by malaria episode compared to people in the indigenous village regardless of higher net ownership and utilization in the former village. The reasons could be due to higher vulnerability to malaria by the resettlers as they might lack immunity because they were recently settled in this malaria endemic region. Or, it could be due to high insecticide resistance development by *An. arabiensis* as evidence elsewhere in the country showed that the vector has already showed increased resistance to several insecticides [22]. And/or it could be due to increased early biting activity [23] and outdoor feeding behavior of *An. arabiensis* [24] that may have a negative impact on the efficiency of LLINs to control malaria. However, the present study didn't analyze insecticide susceptibilities, feeding behavior and blood meal sources for the malaria vectors and need to be addressed as evidence elsewhere in Africa show that despite high coverage with LLINs the burden of malaria remains high [25].

With this end, this study was not without limitations. The main weakness of the study is lack of replicate villages due to scarcity of sufficient resources to address several villages in this remote agricultural settings. Further limitation of this household survey is that it was conducted in peripheral communities where there were limited laboratory facilities and malaria diagnosis was based on clinical diagnosis of patients with fever and self-reported episodes. As a result, some of the episodes classified as malaria by the respondents could have been other diseases, and vice-versa and warrant further parasitological studies with reliable tools in these villages.

1.4. Conclusions
Indoor malaria vector and the disease prevalence were higher in the resettlement village than the indigenous village regardless of relatively higher net ownership and utilization in the former village. Therefore, alternative malaria vector control methods that complement LLINs is required in vector control interventions. Besides, the impact of housing, insecticide resistance and feeding behavior of the target vector on indoor malaria transmission need to be monitored as they negatively impact protective efficacy and effectiveness of LLINs in these malaria venerable villages.

Competing interests
The authors have read the manuscript and declared that no competing interests exist.

Authors' contributions
OK participated to the study design, conducted data collection, analysis and interpretation and drafted and revised the manuscript. HT involved in designing the study, revised the manuscript and has given approval of the version to be published. All authors read and approved the final manuscript.

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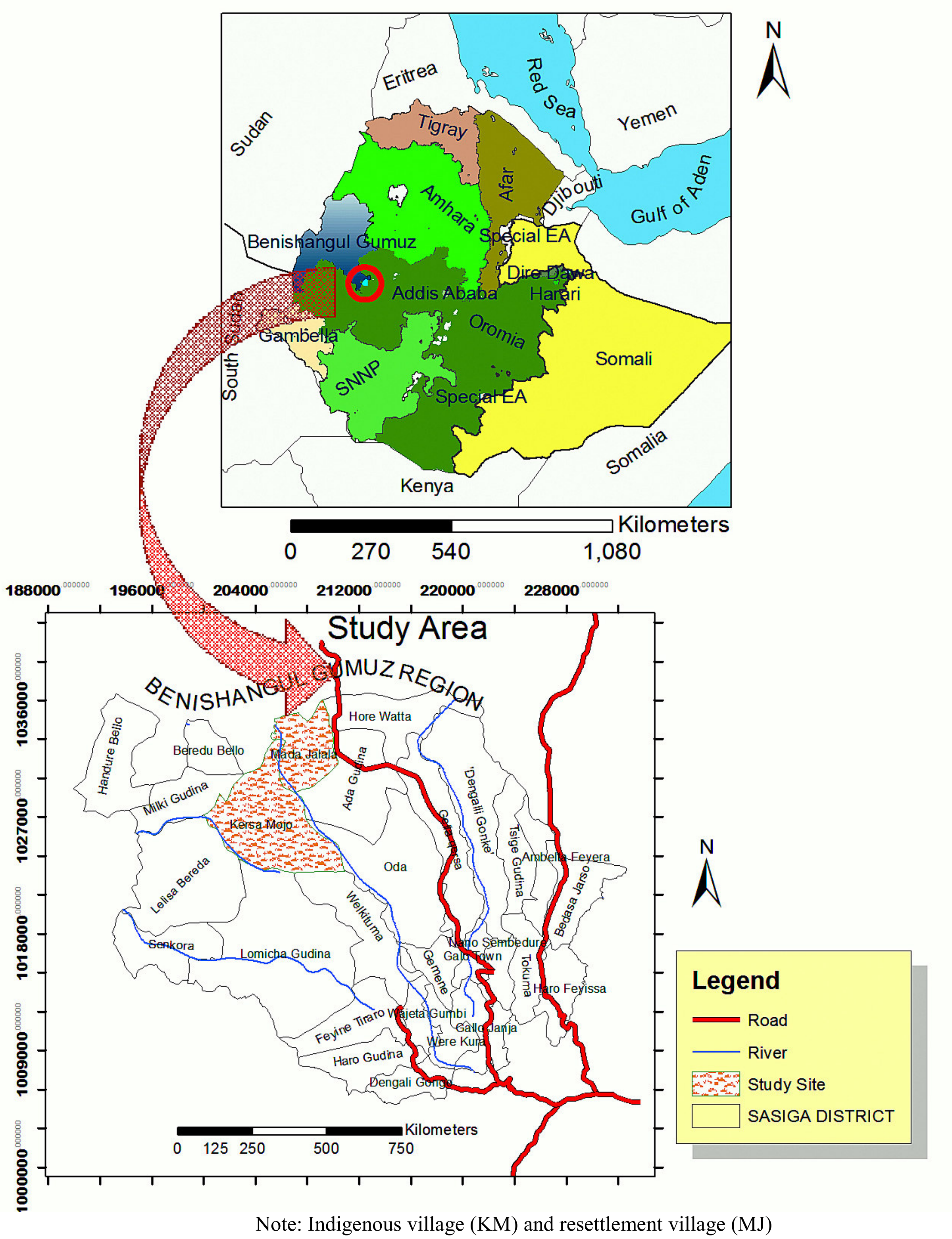
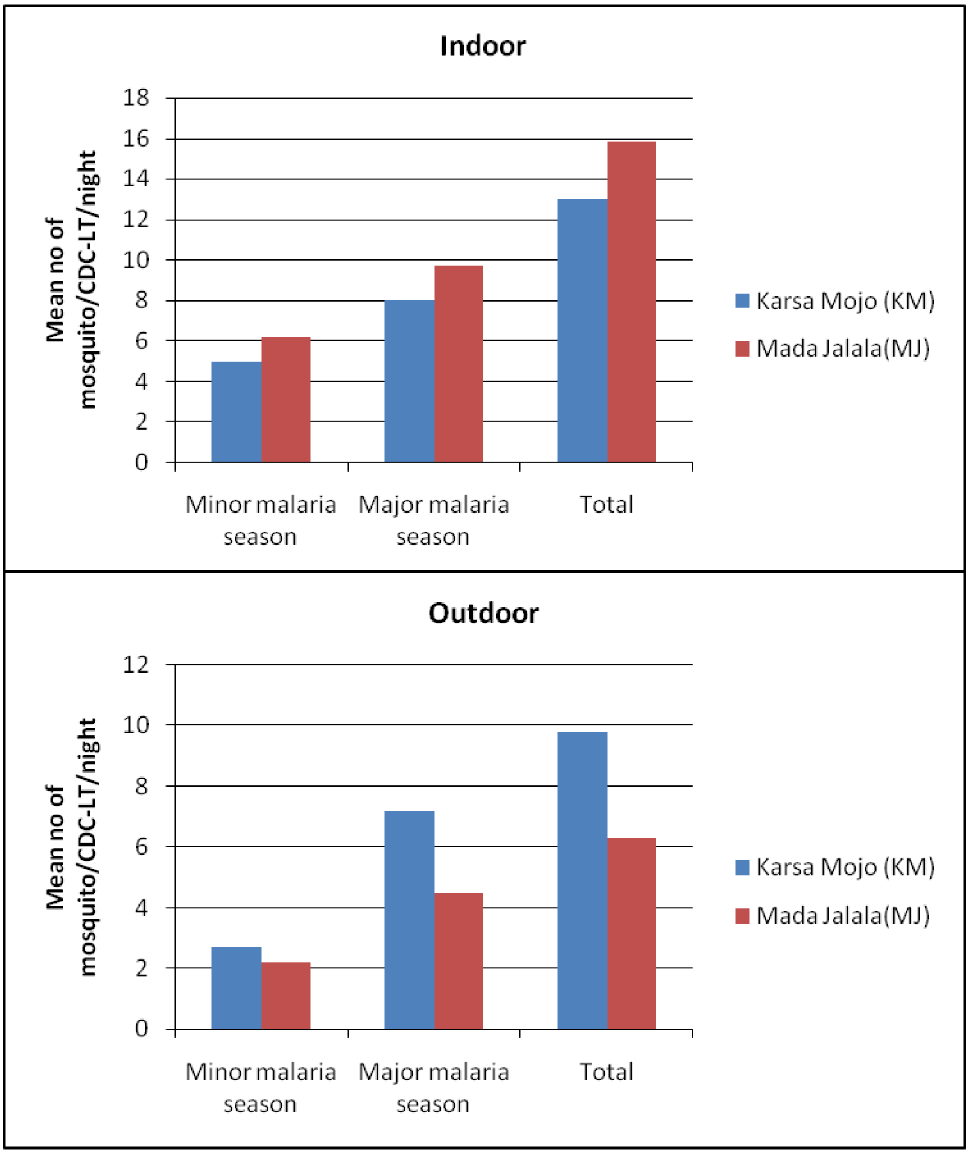


Note: Indigenous village (KM) and resettlement village (MJ)

Figure 1: The study area map and its location in Ethiopia



Note: Indigenous village (KM) and resettlement village (MJ)

Figure 2: Seasonal indoor and outdoor density of *An. gambiae* s.l. in Karsa Mojo and Mada Jalala villages, western Ethiopia

Table 1: Composition of the anopheline collections by village during the dry, minor and major malaria transmission seasons in December 2011- 2012.

	Indigenous village (KM)			**Resettlement village (MJ)**			
Season	*Anopheles gambiae* n (%)	*Anopheles coustani* n (%)	*Anopheles cinereus* n (%)	*Anopheles gambiae* n (%)	*Anopheles coustani* n (%)	*Anopheles cinereus* n (%)	**Total n(%)**
Dry	0	6	0	0	6	0	12(3.6)
Minor	46 (33.6)	2	4	50 (37.6)	8	4	114(34.2)
Major	91 (66.4)	9	6	83 (62.4)	11	7	207(62.2)
Total	137 (41.1)	17 (5.1)	10 (3.0)	133 (40)	25 (7.5)	11 (3.3)	333

Table 2: LLINs possession and utilization of the study participants in the villages

Variables	KM		MJ		Overall	
	f	%	f	%	f	%
Do you have bed nets? No	65	38.0	49	27.2	114	32.5
Yes	106	62.0	131	72.8	237	67.5
Number of nets owned : None	65	38.0	50	27.8	115	32.8
one	81	47.4	102	56.7	183	52.1
More than one	25	14.6	28	15.6	53	15.1
Of those who had nets they obtained:						
from Health post	106	62.6	131	72.8	237	67.5
Market and/or shops	0	0	0	0	0	0.0
Other	0	0	0	0	0	0.0
Did you sleep under net prior night?						
No	65	38.0	50	27.8	115	32.8
Yes	106	62.0	130	72.2	236	67.2
Observed no. of nets used prior night:						
None	94	55.0	104	57.8	198	56.4
Single	75	43.9	73	40.6	148	42.2
Two and above	2	1.2	3	1.7	5	1.4
When did you obtain it (in months):						
< 6 months ago	7	4.1	5	2.8	12	3.4
> 6 months ago	101	59.1	124	68.9	225	64.1

KM=Karsa Mojo (indigenous village), MJ=Mada Jalala (resettlement village), f=frequency (number) of response to each item

Table 3: Predictors of mosquito net ownership by households in the study villages

Predictor variable	Multivariate analysis		
	B	P-value	OR (95% CI)
Use of nets for other purpose	-1.585	0.003	0.205 (0.071 - 0.591)
Save nets for future use	-1.697	<0.001	0.183 (0.095 - 0.352)
Possession of radio	-1.602	<0.001	0.202 (0.123 - 0.331)
Seasons of the year	0.604	0.035	1.829 (1.042 - 3.209)

Table 4: Predictors of mosquito net utilization by households in the study villages

Predictor variable	Multivariate analysis		
	B	P-value	OR (95% CI)
Study villages	-0.466	0.042	0.627 (0.400 - 0.983)
Age of household heads	0.599	0.014	1.820 (1.127 - 2.940)
Use of nets for other purposes	-1.599	0.003	0.202 (0.070 - 0.582)
Save nets for future use	-1.714	<0.001	0.180 (0.094 - 0.346)
Possession of radio	-1.625	<0.001	0.197 (0.120 - 0.324)
Seasons of the year	0.558	0.050	1.748 (1.000 - 3.056)

Table 5: Self-reported malaria episode and number of days lost due to malaria in the villages

Variables	KM		MJ		Over all	
	F	%	F	%	F	%
Has anyone in your family caught malaria in the past three months? No	118	69.0	106	58.9	224	63.8
Yes	53	31.0	74	41.1	127	36.2
If yes, symptoms experienced: None	118	69.0	107	59.4	225	64.1
Fever	32	18.7	37	20.6	69	19.7
Chills	8	4.7	10	5.6	18	5.1
Headache	7	4.1	14	7.8	21	6.0
Loss of appetite	6	3.5	12	6.6	18	5.1
No. of self-reported malaria episode per house:						
None	117	68.4	106	58.9	223	63.5
One	46	26.9	50	27.8	96	27.4
More than one	8	25.0	24	13.3	32	9.1
Days lost due to malaria over 3 months period:						
None	116	67.8	106	58.9	222	63.2
Less than a week	44	25.7	68	37.8	113	32.2
More than a week	11	6.4	6	3.3	16	4.6

KM = Karsa Mojo (indigenous village), MJ = Mada Jalala (resettlement village)