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Original Research

A Six Years Trend of Malaria Prevalence with Respect to Ownership and Use of Long-Lasting Insecticidal Nets in Butajira Town, South Central Ethiopia

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Abstract

A 2015–2020 retrospective study on malaria prevalence and LLIN ownership and use was conducted in Butajira, south-central Ethiopia. Randomly selected town kebeles 01, 02, and 04 were studied for LLINs. Reviewing selected Kebeles' health centers' six-year records revealed malaria prevalence. All sample household heads reported LLIN possession, coverage, and use for each kebele. Data were processed with SPSS 20. We used Chi-square and odd ratios to assess malaria cases and risk factors with 95% confidence. A p-value < 0.05 indicated significance. Microscopy and RDT identified Plasmodium parasites in 1423 malaria cases. In 2016, 883 (62.05%) malaria cases were reported; in 2020, 16 (1.12%). Winter and spring saw greater malaria incidence. Peak cases were 48.3% in 01 Keble, 20.7% of total. The LLINs study included 124 of 6344 randomly selected HHs from the three Kebeles. Free government supply was 118 (98.3%). LLINs were present in 75% of HHs (95% CI: 94.37%–97.43%). Malaria is endemic in town, thus it's been reported all six years. LLINs did not cover all study families. LLIN must be maintained for universal coverage.

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INTRODUCTION

Only 25% of Ethiopians reside in malaria-free zones, making malaria a major public health concern in the country. Abose et al. (1988), Abeku et al. (2003), and Deribew et al. (2017) found that malaria transmission is both seasonal and epidemic, with climate and altitude-related factors playing a major role. The two most common malaria parasites in Ethiopia are Plasmodium falciparum and P. vivax, with 60% and 40% of malaria cases, respectively, as reported by Debibew et al. (2017). According to Krafsur (1977), Abose et al. (1998), and Kenea et al. (2016), Anopheles arabiensis is the main malaria vector in Ethiopia and has a large geographical distribution. On the other hand, An. funestus, An. pharoensis, and An. nili are regarded as secondary malaria vectors. Recent influxes of the Asian malaria vector An. stephensi through the Djibuti seaport have established themselves in the metropolitan centers of eastern Ethiopia (Balkew et al., 2020). Research into the vector's entomological inoculation rate (EIR) is necessary because it is currently unknown.

Between September and December, which happens to be the height of the rainy season in Ethiopia, there is a significant increase in malaria cases. On the other hand, April and May also see a small transmission season (FMOH 2014; 2020). Indoor residual spraying of houses with insecticides (IRS), the use of long-lasting insecticidal nets (LLINs), and larval source management (LSM) are important tools for malaria intervention, particularly in urban areas where there are few, easily identifiable, and permanently located larval habitats (FMOH 2012; 2014). Research conducted by Otten et al. (2009), Alemu et al. (2012), and Gari et al. (2016) has demonstrated that both IRS and LLINs significantly decrease the incidence and prevalence of malaria in the country. Although the prevalence of malaria cases is still high, there has been a considerable decrease in malaria-related morbidity and mortality in Ethiopia since 2001 (Taffese et al., 2018). Improvements in the coverage and utilization of IRS and LLINs, as well as faster case treatment and the prevention and control of malaria in pregnant women through intermittent preventive therapy (IPT) (Otten et al., 2009; Alemu et al., 2012; Bugssa & Tedla, 2020), may be responsible for the decrease.

The elimination campaign has begun in chosen low malaria transmission areas in Ethiopia, in response to the country's goal of eliminating malaria in the next decades (Bugssa and Tedla, 2020). The country's focus has shifted from malaria control to elimination, marking a significant change in strategy. Planning intervention tactics and developing new ones against malaria relies heavily on assessing the trajectory of malaria prevalence and coverage as well as making use of intervention tools. To better understand the dynamics of disease transmission and to assess the efficacy of malaria interventions to control the disease, it would be helpful to analyze the pattern of malaria prevalence in relation to coverage and usage of intervention tools in areas where malaria is prevalent. As far as we are aware, no published reports have addressed the correlation between the usage and ownership of LLINs and the prevalence of malaria in Butajira town. Thus, the purpose of this research is to determine whether there has been an increase or decrease in the prevalence of malaria in Butajira town, south-central Ethiopia, and how this relates to the ownership, coverage, and usage of LLINs.

MATERIALS AND METHODS

The study area

The village of Butajira in the SNNPR, located in south-central Ethiopia, was the site of the study (Figure 1). Located in SNNPR, it is one of the Gurage Zone's administrative cities. The area experiences an average of 1055 mm of rainfall per year with temperatures between 17.4 and 63.4 degrees Fahrenheit throughout the year. But in 2009 and 2010, yearly rainfall was lower than usual. From June through September, the majority of the rainiest months often fall.

The town had a total population of 33,406 in 2007, with 16,923 males and 16,483 women, according to the CSA's Population and Housing Census. Nearly half of the population, or 51.27 percent, identified as Muslims. There has been a noticeable shift in socioeconomic characteristics, and Butajira is currently experiencing fast growth. The town's health has been deteriorating due to malaria. Its spread is erratic and coincides with Kiremt and Belg's rainy seasons. Numerous private clinics complement the town's public hospital and health center.

Its precise coordinates are 8° 715 N, 38° 22:45 E. Meskan and Mareko District, Gurage Zone, SNNPR, Ethiopia is home to the Butajira Rural Health Programme (BRHP), which is based at the Butajira DSS. The total area of the district is 797 km2, with Butajira town occupying about 9 km2. Located in the Rift Valley at 8.2° north latitude and 38.5° east longitude, the location is 130 km south of Addis Ababa and 50 km west of Zuway town.

The Gurage are the largest ethnic group, and they are subdivided into smaller tribes. Important indigenous communities include the Meskan, Mareko, Sodo, Silte, and Dobi. The area's second most popular religion is Orthodox Christianity, followed by Islam with two-thirds of the population following it

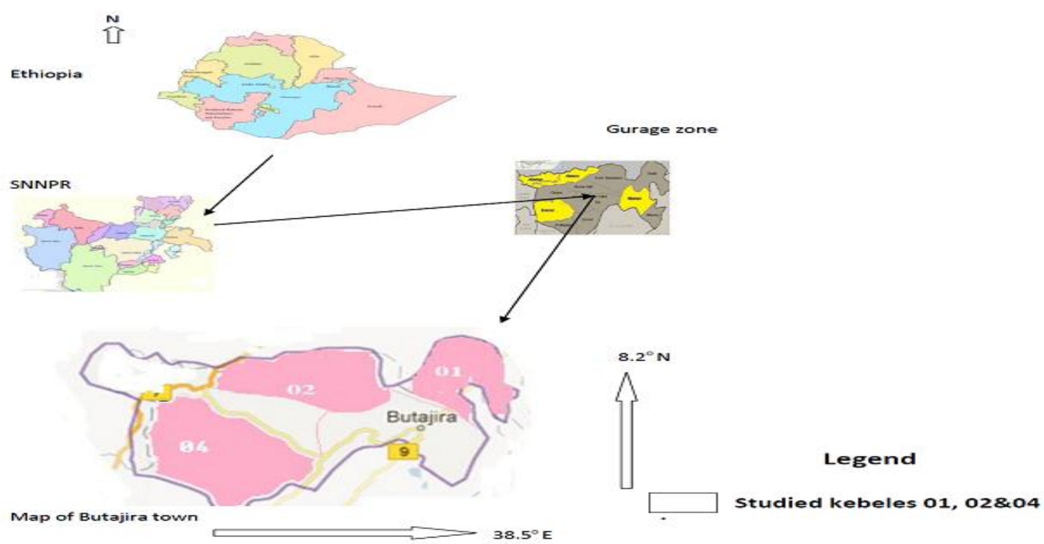

Figure 1. *Geographical location of Butajira town in south central Ethiopia*

Research Methods and Timeframe

For the purpose of analyzing malaria trends, a retrospective study design was utilized. This was accomplished by going through the Town Health Centres' Registration Books from 2015 to 2020. Researchers employed a community-based cross-sectional study design to examine LLIN possession, coverage, and utilization. The research included the months of 2020 and 2021.

Research area

Butajira town in south-central Ethiopia was the site of a community-based cross-sectional survey. Located in SNNPR, it is one of the Gurage Zone's administrative cities. With an expected population of 52,662 and 10,747 homes in 2020, it occupies around 9 km^2 of land. There are a total of five kebeles in the town. People living in all three kebeles of Butajira town made up the research population. We gathered and analyzed data on all confirmed malaria cases from 2015 to 2020 from the Out-Patient Department (OPD) of health care centers (hospitals and health centers) in Butajira town. Additionally, we surveyed households of malarious kebeles (01, 02, and 04) on purpose for the LLINs survey.

Methods of Sampling and Data Sources

Using the registration book in the government health centers in Butajira town, we were able to compile the total number of malaria-positive cases during the study period (2015-2020). The trend of malaria prevalence can be discussed using the data received from the registration book.

Each of the three malarious kebeles received a proportional share of the sample size according to the number of households in their respective areas, ensuring that the sample was representative of the whole. Subsequently, a list supplied by the municipal government was used for systematic random selection to pick households. There are 20,47, 1942, and 2,355 households in the three kebeles that were analyzed.

Sample Size Determination

For the household survey for LLINs, the sample size was determined using the single population proportion formula.

$n = Z^2P\ (1\text{-}P)/d^2$

Where n is the sample size of households. P = proportion of households that slept under LLIN. No previous similar study was carried out in the area, and to get the maximum sample size, P was taken as 50% (P = 0.5). The degree of accuracy required (sampling error) is 5%, that is, d = 0.05. Z = Standard score for 95% confidence level is 1.96. An additional 10% for non-response rates was taken. Substituting the above values, the calculated sample size for the study was 124 households. For the three kebeles LLINs study, a total of 6,344 HHs were enrolled. There are 20,47, 1942, and 2,355 households in the three kebeles that were analyzed. A method of systematic random sampling was used to choose the households. The sample size (n), the total population (N), and the sample interval (k) were all input into the formula K=N/n, which is used to calculate systematic random sampling. Here, K= N/n= 6344/124= 51 might be the sample interval for HHs. In order to continue adding members to the sample (r, r+i, r+2i, etc.), the initial member (r) was randomly chosen and included. A total of 124 HHs were included in the analyzed kebeles samples, with n=40, n=38, and n=46 for each of the three groups.

Tools for gathering information

Data from the selected health centers' monthly case reports of malaria cases were compiled. According to the district health office's report, every kebele's yearly implementation of preventive techniques (IRS and LLINs) was gathered. A pre-formatted file including kebeles, years, months, total households, total households obtaining LLINs, and total dwellings sprayed with IRS was used to gather the raw data.

Ensuring the accuracy of data

Malaria cases were classified into three groups: total cases, suspected cases, and diagnosed cases. Monthly breakdowns of confirmed malaria cases were used to illustrate the seasonal trend of the disease overall years. In order to ensure the data was accurate and reliable, it was necessary to double-check the information gathered from each health center with the district report. Inconsistencies were corrected and double-entry of data was performed.

Analysis of Data

Coding and categorizing the data prior to data entry helped to organize and process it. Excel 2007 spreadsheets from Microsoft Office showed the data. An analysis was conducted using SPSS version 20 on data entered into an Excel spreadsheet. To find out how the interventions were related to malaria trends, we employed two-way ANOVA and chi-square. Figures and tables were used to summarize the results of the retrospective study on malaria and the coverage of IRS and LLINs.

RESULTS AND DISCUSSION

Results

The overall annual prevalence of malaria cases

Data on malaria prevalence over the past six years (2015–2020) in Butajira town are presented in Figure 2. Accordingly, a total of 402 malaria cases in 2015, 883 in 2016, 65 in 2017, 36 in 2018, 21 in 2019, and 16 in 2020 were reported from the health care systems. Of the total 1423 malaria cases reported in the six consecutive years, the prevalence of the cases was decreasing, except that the highest prevalence (883 (62.1%) was observed in 2016 and the lowest was in 2020, with a prevalence rate of 16 (1.1%).

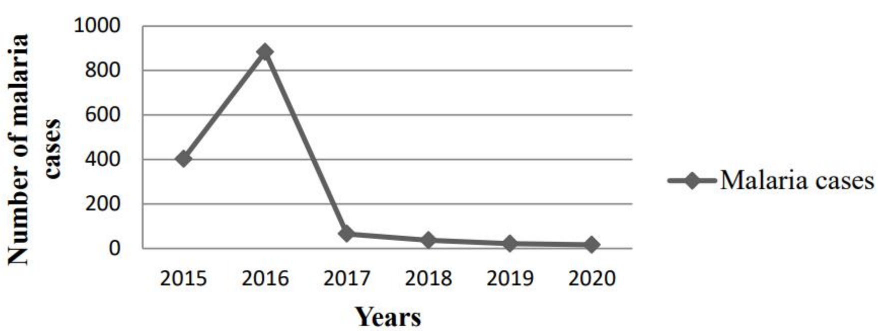

Figure 2. *The trend of malaria case in Butajira town from 2015-2020*

Prevalence of malaria cases by sex group

Table 1 shows the prevalence of malaria cases by sex group. As it can be seen from the table, a male-to-female infection ratio of 3:1.2 was observed, equivalent to a prevalence of 65.9%–34.1%, indicating males were almost twice as vulnerable to malaria as females. The vulnerability of males to malaria infection did show little change in the male-female malaria infection ratio (1.2:1) in 2017 and 2020. Even though the differences were statistically insignificant, the record figuratively revealed that males were slightly more affected than females in 2015, 2016, 2018, and 2019.

Table 1

Prevalence of malaria cases in Butajira by sex groups from 2015-2020

Year	Sample size					Number of positive samples to malaria					M:F ratio	P-value
	M	%	F	%	Total	M	%	F	%	Total		0.33
2015	242	60.2	160	39.8	402	140	55.6	112	44.4	252	1.3:1	
2016	620	70.2	263	29.8	883	148	55.7	120	44.3	268	1.4:1	
2017	33	50.8	32	49.2	65	23	53.5	20	46.5	43	1.2:1	
2018	17	47.2	19	52.8	36	16	57.1	12	42.9	28	1.3:1	
2019	15	71.4	6	28.6	21	7	63.6	4	36.4	11	1.7:1	
2020	11	68.75	5	31.25	16	5	55.6	4	45.4	9	1.2:1	

Note: M= Male, F= Female, M: F= Male to female ratio.

Malaria incidence rates broken down by age group

Malaria is most common in those aged 15 and up (57.5). The next high-risk category, however, consisted of those aged 5 to 14, with a prevalence of 30.1%. According to Table 2, 8.6% of the participants in this study were under the age of five and had malaria.

Table 2

Prevalence of malaria by age groups in Butajira town from 2015-2020

Age (Years)	Years							
	2015	2016	2017	2018	2019	2020	Total	P
<5	77(22.3%)	135(19.2%)	11 (17%)	6(16.7%)	2 (9.5%)	3(18.75%)	234(16.4)	0.32
5-14	115(28.65%)	264(29.9%)	20(30.7%)	12 (33.3)	5(23.8%)	5(31.25%)	421(29.6)	
15+	200(49.75%)	463(52.0%)	34(52.3%	18(50%)	14(66.7%)	8(50%)	737(51.7)	
Total	402(28.3)	883(62.1)	65(4.7)	36(2.5)	21(1.5)	16(1.1)	1423	

Seasonality of malaria

The current study found that the distribution of malaria in the study area was significantly affected by the seasons ($p<0.05$), with winter and spring having greater illness rates compared to other seasons. In terms of study years, the months with the somewhat higher prevalence were May, July, September, November, and December in both 2015 and 2016. July, September, and November seem to have the highest rates of confirmed malaria cases (Figure 3).

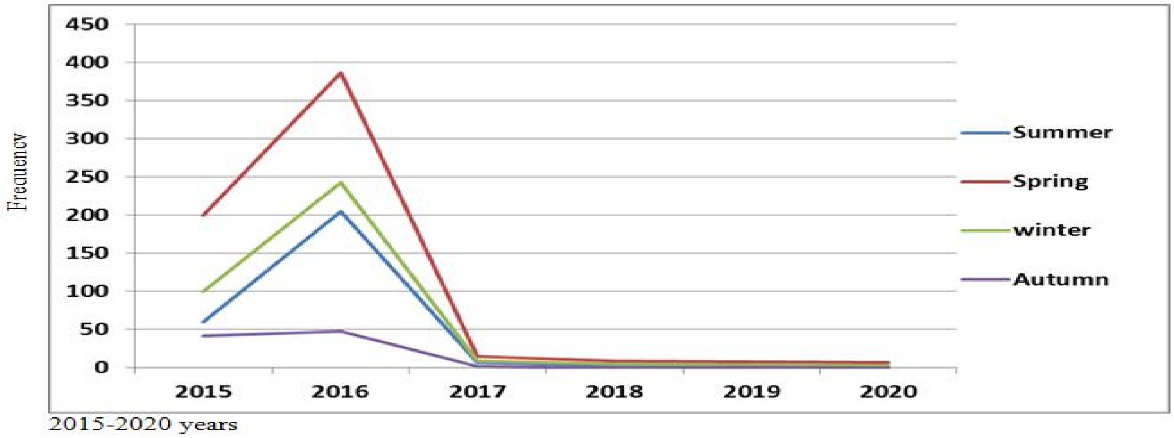

Figure 3. *Seasonal Prevalence of plasmodium species in Butajira town*

The prevalence of malaria parasites

The most common species of Plasmodium in the 1423 instances of microscopically confirmed malaria was Plasmodium vivax (687 cases, or 48.2%), followed by Plasmodium falciparum (725 cases, or 50.9%). Figure 4 shows that seven instances, or 0.8% of the total, of microscopically confirmed malaria were mixed kinds infections, meaning that blood films showed both P. falciparum and P. vivax species.

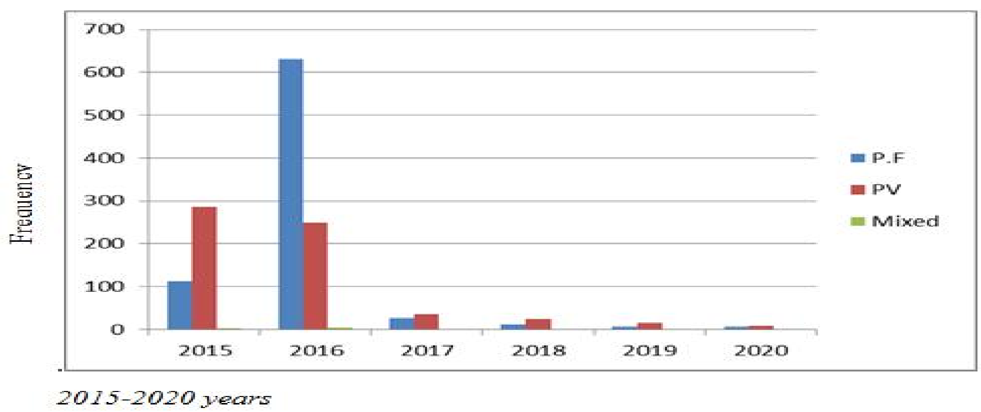

Figure 4. *Prevalence of plasmodium species in Butajira town*

Possession, coverage and use of LLINs in Butajira town

LLINs possession

The majority of individuals in the research region possessed Long-Lasting Insecticidal Net Ownership. There were 110 responders (91.7%) who had LLINs and 10 (8.3%) who did not. According to Table 3, 118 out of the 143 respondents who have LLINs received them as freebies from the government, while 2 (1.7% of the total) received them as gifts.

Table 3

LLINs Possession in Butajira town

LLINs possession	Frequency	Percent
Is there insecticide treated bed net in your house (n=120)		
Yes	110	91.7
No	10	8.3
Source of bed net (LLINs)		
freely supplied by government	118	98.3
Purchased	0	0
Gift	2	1.7

LLINs coverage

A total of 91 (75.6%; 95% CI: 94.37%-97.43%) HHs were found to have at least one LLIN. Even though 96.7% of the houses possessed LLINs, just 95 (or 79.1%) of the people living there had slept under one the night before the interview. Per the respondent's estimation, there was a subset of homes in which members with children younger than five years old (34.7%), pregnant women (21%), and all other families (56%). Table 4 shows that there were 61 families with 1-4 children, 49 families with 5-7 children, and 17 families with 13.7 children.

Table 4

LLIN coverage in three selected kebeles of Butajira town

Description	Kebeles			
	01(n=40) n(%)	02 (n=38) n (%)	03(n=46) n(%)	(n=124) n (%)
LLIN owned n=124				
Yes	37(92.5)	37(97.3)	43(93.5)	120(96.7)
No	3(6.5)	2(2.7)	3(6.5)	4(3.3)
last night LLINs used n=120				
Yes	30(76.9)	30(81.1)	35(79.5)	95(79.1)
No	9(23.1)	7(18.9)	9(20.5)	25(20.9)
LLINs/HH (n=120)				
one	29(74.3)	26(70.3)	36(81.8)	91(75.8)
Two	8(20.5)	9(24.3)	7(15.9)	24(20)
more than two	2(5.2)	2(5.4)	1(2.3)	5(4.2)
LLIN used by (n=95)				
number of children < 5 years	18(6.4)	11(8.5)	14(11.3)	33(34.7)
Family size				
1-4	12(9.6)	13(10.5)	17(13.7)	61 (49.2)
5-7	18(14.5)	21(16.9)	22(17.7)	49 (39.5)
>8	8(6.4)	5(4)	8(6.4)	17(13.7)

Utilization of LLINs

In terms of how often and consistently people use LLINs, 63.3% of households use them annually, whereas 68.7% use them only during times of high transmission (when mosquitoes are present). There were 95 (79.1) family members who indicated they slept under the net last night, according to the condition (Table 4.9). Of the total participants, 20 (16.5%) slept under LLINs the night before the survey, and out of them, 14 (70%) used them. Approximately 34.7 percent of youngsters slept under LLINs before the survey.

Table 5

Utilization of LLINs in Butajira town

Bed net Utilization	Frequency	Percent
Frequency of sleeping under LLINs (n=120)		
Always	52	(43.3%)
Sometimes	68	(56.7)
Family member slept under net last night (n=120)		
Yes	95	79.1
No	25	20.9
Pregnant Women utilized LLINs previous night		
Yes	14	70
No	6	30
all of them	60	60.3
One	28	29.5
Two	5	5.3
Three	2	2.1

Discussion

Cases of malaria have been falling for four years running from 2017 to 2020, with the exception of 2015 and 2016. Consequently, 2016 had the highest prevalence of 883 instances (62%), which was 33.9% greater than 2015's 28.2%, while 2017 saw a sudden drop of 4.6% ($p \leq 0.05$) ($P = 0.033$). This study found that the high coverage and utilization of LLINs in the study area could explain the falling trend of malaria. Additionally, additional research is needed to determine whether the unexpected spike in malaria cases in 2016 is influenced by climate conditions. Malaria was more common in males than females in the region under investigation. Compared to the study in Kola Diba (53% to 47) (1.1:1), the average male to female infection ratio of malaria in Butajira town was 65.9% to 34.1% (Alemu et al., 2011). To be expected, given that nighttime outdoor employment puts males at greater risk of mosquito bites than females in most regions of Ethiopia (Kenea et al., 2016). This study found a somewhat lower prevalence of malaria in the age category of 15+ (42.9%) compared to Kola Diba (50%) (Alemu et al., 2011). A greater prevalence of 26% was noted in the next high-risk category of 5–14 year olds compared to the same data in Kola Diba (19.9%). Every year, reports of Plasmodium vivax and Plasmodium falciparum were made. The most common species of Plasmodium, with 725 cases (51.2%), was Plasmodium falciparum. Plasmodium vivax was the second most common, with 687 cases (48.3%). The remaining cases (0.5%) were mixed-type infections, where blood films showed both Plasmodium falciparum and Plasmodium vivax species. According to WHO(2017) malaria monitoring, P. falciparum is the parasite most commonly found in sub-Saharan Africa, where it was projected to cause 99% of malaria cases in 2016.

Other regions of Ethiopia also documented P. vivax dominance. As an example, Woyesa et al. (2012) also found that P. vivax was more common in Butajira and the adjacent areas than P. falciparum; 86.5% of patients tested positive for P. vivax, 12.4% for P. falciparum, and 1.1% for a mixed infection. While P. falciparum was more common than P. vivax in this survey's 2016 results (71.3:28.7%), the ratio in the Kola Diba Health Centre between 2002 and 2011 was 75%:25% (Alemu et al., 2011).

Malaria was a year-round problem in the research region. While the number of malaria cases fluctuated significantly, the peak was in the fall and winter (September–November) at 43.9%, then in the winter months of December–February at 25.5%, and finally in the spring (March–May) at 6.5%. The main rainy season in Ethiopia happens between September and December, which is also the peak transmission season for diseases (Abeku et al., 2003; Deribew et al., 2017). A secondary, less severe transmission season happens in April and May.

A total of 91 (75.6%; 95% CI: 94.37%-97.43%) HHs were found to have at least one LLIN. Even though 96.7% of the houses possessed LLINs, just 95 (or 79.1%) of the people living there had slept under one the night before the interview. When it comes to the constant and regular use of LLINs, 68.7% of families use them exclusively during periods of high transmission, whereas 52.3% use them less than half of the time. Nevertheless, a total of 95 individuals (79.1%) in Butajira town used LLIN. Of those, 34.7% prioritized children under five years old and 21.0% pregnant women. Using an LLIN is now the gold standard for protecting yourself against mosquito bites and malaria. While our data indicated that 75.8% of homes in malaria-endemic areas owned at least one LLIN, the malaria indicator survey report indicated that 54.8% of families living less than 2,000m did not. The causes behind this could be related to the widespread deployment of LLINs across the nation, according to FMOH (2020). The approach requires appropriate follow-up on LLIN usage and sufficient surveillance, in addition to distributing nets, which could be the reason. Nearly identical to our result, a study conducted in the Arbaminch areas of Ethiopia found that 73% of LLINs were utilized (Ayalew et al., 2015). Consistent with our results, another study in Raya Alamata District, Ethiopia, also discovered that 68.6% of LLINs were in use (Araya et al., 2015).

CONCLUSIONS

Increasing ownership, coverage, and utilization rates of LLINs throughout the years have had a major impact on the incidence of malaria in Butajira town, and the results show that the prevalence of malaria has been dropping over the past six years, from 2015 to 2020. P. falciparum was the most common malaria parasite in the areas where the study was conducted, with P. vivax coming in a close second. As the study progressed, it became clear that LLIN coverage had been steadily rising, which greatly affected illness dispersion. Nonetheless, malaria has been documented for each of the six years because the disease is still endemic in the community. It is important to address the fact that the LLINs did not reach every household in the research region in order to achieve universal coverage.

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DECLARATION

The authors declare that they have no conflicts of interest.

DATA AVAILABILITY STATEMENT

All data generated from the field experiments and reported in the manuscript are included in the article. Further data sets are available from the corresponding author upon request.

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