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Five Year Trend of Malaria Prevalence and Coverage of Core Frontline Interventions in Abe Dongoro District, Western Ethiopia

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Abstract

A five year (2015-2019) retrospective study with an aim to assess the trend of malaria prevalence and coverage of core frontline control interventions was undertaken in Abe Dongoro district, Western Ethiopia. The kebeles (lowest administrative units) of the district were primarily stratified as malarious and non-malarious. From the malarious group, three kebeles (Amba 15, Amba 24 and Amba 20) were randomly selected for the study. Secondary data of malaria prevalence were collected by reviewing the five years reports of the health centers in the selected Kebeles. Data of the core malaria prevention tools particularly Indoor residual spraying (IRS) and long-lasting insecticidal nets (LLINs) coverage of each kebele were obtained from the reports of the district's health office. The data were analyzed using SPSS version20 statistical software. Chi-square for qualitative and ANOVA for quantitative data were used to determine the association between malaria cases and risk factors at 95% confidence level and significance was taken with p-value <0.05. Results revealed that a total of 1762 patients were laboratory tested for malaria, of which 953(54.1%) were confirmed for the presence of *Plasmodium* parasites by malaria diagnostic tools. The highest number of malaria cases (1010) was recorded in 2015 and the lowest number (29) in 2019. Of the 953 microscopically confirmed malaria cases, *P. falciparum* was observed in 584 (61.28%) followed by *P. vivax* 369 (38.72%). Significantly highest proportion of cases were recorded in Amba 20 (46.3%) followed by Amba 24 (36.3%). The coverage of IRS and LLINs were significantly increasing with year advance at rate of 34.42% and 58.35% respectively. In conclusion, the prevalence of malaria in Abe Dongoro district showed a consistent declining trend from the year of 2015-2019 coupled with increasing coverage rate of IRS and LLINs over the five years. This implies the potential towards malaria elimination with universal coverage of IRS and LLINs in the study setting. Therefore sustainable operational distribution and coverage of IRS and LLINs are required to eliminate malaria in Abe Dongoro district.

Keywords

Abe Dongoro, Five Year Malaria Trend, Coverage of IRS and LLINs, Malaria

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1. Introduction

Malaria remains one of the most severe public health problems in Ethiopia, where only 25% of the populations live in areas that are free from the disease burden. Malaria transmission is seasonal and epidemic mainly depending on altitude and climatic variations [1, 2, 3]. *Plasmodium falciparum* and *P. vivax* are the most prevalent malaria parasites in Ethiopia accounting for 60% and 40% of malaria cases respectively [3].

Anopheles arabiensis is the sole principal malaria vector in Ethiopia and has wide geographical distribution whereas *An. funestus, An. pharoensis*, and *An. nili* are considered secondary malaria vectors [4, 1, 5]. *An. pharoensis* has been shown to have high human biting rates but is more exophilic than *An. arabiensis* [5], *An. funestus* is highly anthropophilic

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but has limited geographical distributions around lake shores and swamps [6, 5,], *An. nili* may not be targeted by vector control interventions due to its tendency to bite indoors but rest outdoors [4]. High malaria transmission intensity occurs as *An. arabiensis* populations expand during the wet seasons [3, 5]. Malaria transmission peaks from September to December coinciding with the major rainy season. A minor transmission season also occurs in April–May [2].

Indoor residual house spraying **(**IRS) and long-lasting insecticidal nets (LLINs) are the core frontline life-saving malaria control interventions in Ethiopia [7, 8]. Both IRS and LLINs have proven to be highly effective at reducing malaria incidence and prevalence in the country [9, 10, 11]. Because of the intensive use of IRS and LLINs in the country malaria morbidity and mortality have been significantly reduced since 2001, though, malaria case incidence is still high [12]. The decline could be as the result of enhanced coverage of high impact interventions, such as prompt treatment of cases, prevention and control of malaria among pregnant women using intermittent preventive therapy (IPT) and coverage and use of IRS and LLINs [9, 10, 13].

In recognition of malaria decline since 2001, Ethiopia is planning to eliminate malaria in the upcoming decades [13]. The country has been promoting universal coverage of both IRS and LLINs for malaria control and elimination [13]. In the derive to eliminate malaria, analyzing malaria prevalence trend and the intervention mechanisms employed each year are significantly important for planning intervention strategies and to design new ones to tackle the disease. However, the overall trend of malaria prevalence and the frontline intervention tools such as IRS and LLINs have not been studied and well-documented in different localities in general and in Abe Dongoro District in particular. Analyzing the pattern of malaria prevalence and coverage of core intervention tools in endemic areas of malaria would help to understand the dynamics of the disease transmission and to evaluate the effectiveness of malaria interventions to control the disease. The present study, therefore, aims to assess the trend of malaria prevalence in Abe Dongoro district and coverage of major intervention tools in the area.

2. Methods

2.1. The Study Area

The study was conducted in Abe Dongoro District (ADD) in Oromia Regional State, Western Ethiopia. The administrative town of ADD, Tulu Wayu is found 361 km from the Ethiopian capital Addis Ababa. It is geographically located at 9° 45'N latitude and 36°45'E longitude at an alleviation that ranges from 1300 to 2800 meters above sea level (m.a.s.l.).

The Average total rainfall of the area is 2125 mm, which varies from about 1750 mm to 2500 mm locally. The district experiences four seasons per year namely; autumn (September to November), winter (December to February), spring (March to May) and summer (June to August). The four seasons are locally called Birra, Bona, Arfasa and Ganna respectively. The rainy season starts in the first month of spring (Arfasa) and lasts to the end of the last month of autumn (Birra) with highest rainfall time occurring during summer (*Gann*a) that takes place from June to September.

The average temperature of the area is estimated to be 22°C which may vary with altitude and seasons. In the highlands of the district, the temperature may drop to the lower value during the months of November to January. In the lowlands of the area the average temperature increases from 20°C to 32°C during summer.

According to 2007 national census reports, ADD had a total population of 67,017, of which 50.93% were male and 49.07% were female; 2,519 (3.76%) of its population were urban dwellers (CSA, 2007). Agriculture is the main economic activities of the district, which involves mixed farming, with both crop production and livestock rearing. The area is known in producing cash crops such as coffee, pulse seeds, sesames, and spices such as red pepper, and ginger. Food crops such as maize, wheat, teff and barely and food animals such as cattle, goat, sheep and honeybee products are produced. The district constitutes 1 hospital, 21 clinics and 7 health centers.

2.2. Study Design and Period

A retrospective and cross-sectional study design was employed for the malaria trend analysis. The retrospective study was done by reviewing the total malaria cases of the health centers for the past 5 years (2015–2019). For IRS and LLINs coverage studies facility-based cross sectional design was used in which annual distribution reports of IRS and LLINs to each study kebele were obtained from the district health office.

2.3. Study Population

The population of ADD data were collected and reviewed on all Out-Patient Department (OPD) cases, from Tullu Wayu Health Centre, Amba-24 Health Center and Amba-20 Health Centre who were malaria confirmed from 2015 to 2019.

2.4. Sampling Procedures and Sources of Data

The health centers in the district were primarily clustered according to their geographical situation as which were situated in malaria belt area and which were not. The sampled health centers were randomly selected from the category of malaria belt area by simple random sampling

method. The studied Kebeles were in turn selected randomly from the kebeles served in the selected health centers according to their proximity. The five years (from 2015 to 2019) report of the malaria cases and coverage of prevention methods in the selected kebeles were reviewed accordingly.

2.5. Data Collection Instruments

Monthly records of malaria cases from the case report were collected from the record in the selected health centers. Annual execution of application of prevention methods (IRS and LLINs) of each kebele was obtained from report of the district health office. The raw data were collected using pre-prepared format containing kebeles, years, months, total household, total household obtained LLINs and total houses sprayed with IRS.

2.6. Data Quality Control

Data were categorized into total Out-patient Department cases, suspected malaria cases and diagnosed malaria cases. The numbers of confirmed malaria cases were categorized by months for all the years, to describe the seasonal pattern of malaria. Quality control and assurance of the data were put in place in such a way that the data collected from each health center were rechecked from the report of the district. Double data entry was done and inconsistencies resolved.

2.7. Data analysis

The data were organized and processed by categorizing and coding them before data entry. Data were displayed into Microsoft office excel worksheet 2007. Data entered into Excel spread sheet were analyzed using SPSS ver.20. Two-way-ANOVA and Chi-square were used to determine the relationship between malaria trends and application of the interventions. The result of the retrospective study of malaria, and coverage of IRS and LLINs were summarized using figures and tables.

3. Results

3.1. Annual Prevalence of Malaria Cases

A 5-year (2015–2019) malaria data from ADD is summarized in Table 1. Of 1762 total malaria cases reported in the five consecutive years, the prevalence of the cases was decreasing in which the highest prevalence 1010/1762 (57.3%) was reported in 2015 and the lowest was in 2019 with prevalence rate of 29/1762 (1.65%). Out of 953 total microscopically confirmed malaria cases *P. falciparum* 441(46.3%) was the most dominated species followed by *P. vivax* 369 (38.7%). The rest 143 (15%) microscopically confirmed malaria cases were mixed infections that means both *P. falciparum* and *P. vivax* species were observed in the blood films. In all the study periods *P. falciparum* was greater than *p. vivax*, but only in the study period of 2019(50%) *P. vivax* was equal to *P. falciparum*. However, mixed cases were very low throughout the study period.

Table 1. Annual prevalence of malaria in Abe Dongoro District from 2015-2019.

Variables	Categories	Years				
		2015	2016	2017	2018	2019
Sex	Male	523 (51.8)	203 (51.4)	119 (50.9)	48 (51.1)	14(48.3)
	Female	487 (48.2)	192 (48.6)	115(49.1)	46 (48.9)	15 (51.7)
Age	Under 5 years	215 (21.3)	83(21.0)	47 (20.1)	21 (22.3)	6 (20.7)
	5 to 15 years	337 (33.4)	131(33.2)	79(33.8)	31 (33.0)	10(34.5)
	Above 15	458 (45.3)	181 (45.8)	108 (46.2)	42 (44.7)	13 (44.8)
Kebeles	Amba 15	166 (16.4)	91(23.0)	50(21.4)	0 (0.0)	0 (0.0)
	Amba 24	364 (36.0)	140 (35.4)	109(46.6)	20(21.3)	6(20.7)
	Amba 20	480 (47.5)	164 (41.5)	75 (32.1)	74 (78.7)	23 (79.3)
Case Group	Clinical Cases	462 (45.7)	182 (46.1)	106 (45.3)	44 (46.8)	15(51.7)
	Total confirmed	548(54.3)	213(53.9)	128(54.7)	50(53.2)	14(48.3)
	P. falciparum	251 (24.9)	100 (25.3)	59 (25.2)	24 (25.5)	7(24.1)
	P. vivax	215 (21.3)	80 (20.3)	47 (20.1)	20 (21.3)	7 (24.1)
	Mixed	82 (8.1)	33 (8.4)	22 (9.4)	6 (6.4)	0(0.0)

3.2. Risk Factors Associated with Annual Prevalence of Malaria

Within the past 5 years (2015-2019), a total of 1762 patients visited the health facilities from the study kebeles for malaria cases. Out of 1762 patients, 907 (51.5%) were males and the rest 855 (48.5%) were females. It was found that of the total patients examined, 372 (21.1%) were under age of 5 years, 588 (33.4%) were in the age of 5 to 15 years and 802 (45.5%) were above 15 years old. Individuals above 15 years old were significantly more affected than those under 5 years and between 5 and 15 years old in all years of the study except in 2019 ($p<0.05$) (Table 2).

Table 2. Risk factors associated with malaria prevalence in Abe Dongora District.

Variables	Category	Years				
		2015	2016	2017	2018	2019
Sex	Male	523 (51.8)	203 (51.4)	119 (50.9)	48 (51.1)	14 (48.3)
	Female	487(48.2)	192(48.6)	115(49.1)	46 (48.9)	15 (51.7)
	Chi-square	1.283	0.306	0.068	0.043	0.034
	P-value	0.257	0.58	0.794	0.837	0.853
Age	Under 5 years	215(21.3)	83 (21.0)	47 (20.1)	21(22.3)	6 (20.7)
	5 to 15 years	337 (33.4)	131 (33.2)	79 (33.8)	31(33.0)	10 (34.5)
	Above 15 years	458 (45.3)	181(45.8)	108 (46.2)	42 (44.7)	13 (44.8)
	Chi-square	87.697	36.476	23.872	7.043	2.552
	p-value	0.00	0.00	0.00	0.03	0.279
Kebeles	Amba 15	166 (16.4)	91(23.0)	50(21.4)	0 (0.0)	0 (0.0)
	Amba 24	364 (36.0)	140 (35.4)	109(46.6)	20(21.3)	6(20.7)
	Amba 20	480 (47.5)	164 (41.5)	75 (32.1)	74 (78.7)	23 (79.3)
	Chi-square	149.758	21.028	22.487	31.021	9.966
	p-value	0.000	0.000	0.000	0.000	0.002
Case Group	Clinical Cases	462 (45.7)	182 (46.1)	106 (45.3)	44 (46.8)	15(51.7)
	P. falciparum	251 (24.9)	100 (25.3)	59 (25.2)	24 (25.5)	7(24.1)
	P. vivax	215 (21.3)	80 (20.3)	47 (20.1)	20 (21.3)	7 (24.1)
	Mixed	82 (8.1)	33 (8.4)	22 (9.4)	6 (6.4)	0(0.0)
	Chi-square	294.531	117.537	63.607	31.447	4.414
	p-value	0.000	0.000	0.000	0.000	0.110

3.3. Seasonal Prevalence of Malaria

Malaria prevalence was significantly higher in summer and spring than in other seasons ($p<0.05$). The seasonal prevalence of malaria showed similar pattern in 2015 and 2016 reflecting high peaks in May through July. Similarly, the seasonality of the disease was similar in 2018 and 2019 that highest prevalence was seen in July and swift declining in August and almost remain declining to Zero in March to Jun. However, in 2017 there was fast declining from high peak in July to December and remains almost uniform till April and became peaked in May and Jun (Figure 1).

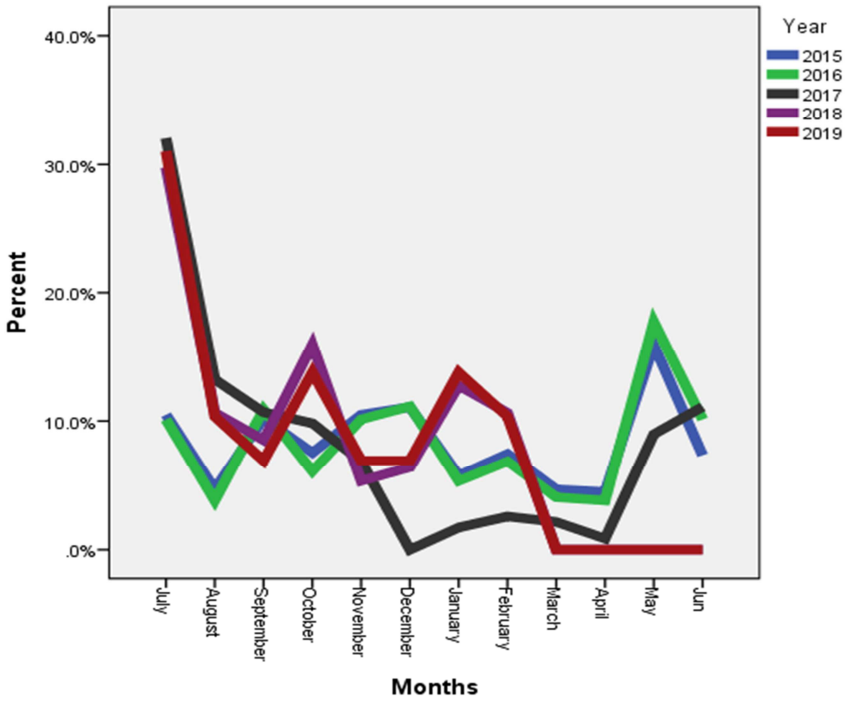

Figure 1. Monthly malaria prevalence in Abe Dongoro District from 2015-2019.

3.4. IRS and LLINs Coverage in Abe Dongoro District from 2015-2019

Table 3 shows the IRS and LLINs coverage rates in ADD from 2015-2019. The proportion of IRS and LLINs distribution and coverage in the last five years in the study area were increasing with coverage rate of 34.42% and 58.35% households respectively.

Table 3. IRS and LLINs Coverage in Abe Dongora District from 2015-2019.

Intervention type		years				
		2015	2016	2017	2018	2019
Mean LLINs distributed	mean	373.00	516.67	731.67	940.33	1079.33
	St. dev	116.77	217.39	352.65	384.18	451.32
Mean LLINs coverage	mean	35.10	46.67	63.33	76.67	85.03
	St. dev	5.05	2.80	2.89	2.89	0.06
Mean IRS application	mean	114.00	278.00	461.67	734.67	1018.33
	St. dev	55.49	128.421	214.26	306.82	424.85
Mean IRS coverage	mean	10.17	24.74	40.00	59.83	80.23
	St. dev	0.29	0.31	0.00	0.29	0.25

The ANOVA analysis of the coverage rate of the intervention methods revealed that there is significant increment in the rate in the five consecutive years (2015-2019) ($p<0.05$) (Table 4).

Table 4. ANOVA Analysis of coverage of application of intervention methods against malaria in Abe Dongoro district from 2015-2019.

Intervention coverage	years					d.f.	F	p-value
	2015	2016	2017	2018	2019			
Mean IRS	10.17	24.74	40.00	59.83	80.23	4	35763.209	0.000
Mean LLINs	35.10	46.67	63.33	76.67	85.03	4	127.896	0.000

There were no significant variation among the kebeles in coverage of the interventions ($p>0.05$) (Table 5).

Table 5. IRS and LLINs household coverage among the Kebeles in Abe Dongoro District.

Intervention type		Kebeles		
		Amba 15	Amba 24	Amba 20
Mean ITN distributed in number	mean	472.60	648.40	1063.60
	St. dev	168.651	276.057	433.350
Mean ITN coverage of households in percent	mean	63.000	61.060	60.000
	St. dev	18.2210	21.6010	22.3607
Mean IRS application in number	mean	329.20	464.60	770.20
	St. dev	234.394	328.744	519.967
Mean IRS coverage of households in percent	mean	42.9800	43.0000	43.0020
	St. dev	28.01432	27.74887	27.62343

4. Discussion

The study found that the malaria cases had been decreasing in the five consecutive years. Such decline in malaria burden has been recorded in many WHO regions. WHO [14] reported that the number of malaria cases in 2015 was estimated to be 214 million and most of these cases (88%) occurred in the African Region. A retrospective study conducted by Girum *et al*. [15] stated that in 2016 there were an estimated 2,927,266 new malaria cases in Ethiopia. In agreement with the current study, WHO [16] reported that estimated numbers of new malaria cases declined by 60% in years between 2010 and 2016. A ten years reports from Asendabo Health center in south west Etiopia indicated that the trend of malaria had a declining pattern, from 27.9% in 2007 to 0.62% in 2016 [17]. Six year (2011–2016) retrospective study of malaria cases conducted by Tesfay *et al.,* [18] in Raya Azebo district of Tigray region has also observed that a total of 29,930 cases were reported from the district and malaria cases had been reported in all of the studied years, with the highest number of cases reported in 2016 (28.9%). In contrast to the current study, Feleke *et al.* [19] reported a slightly increasing of malaria prevalence in Ataye district of North Showa from 7.1% in 2014 to 10.7% in 2016. The difference could be explained in terms of intervention coverage. The trend of the coverage of the malaria intervention tools in the present study was increasing over the five years unlike the former study in north Showa that might affected the decreasing trend of malaria cases. However the trend of coverage of the intervention tools in north Shoa was not reported.

Results also show that of 953 (54%) microscopically or RDT confirmed malaria cases, *P. falciparum* was the most prevalent species with 46.3% and followed by *P. vivax* 38.7% and the rest cases (15%) were mixed type of infection where both *P. falciparum* and *P. vivax* species were observed in the blood films. In line with these results, WHO [20] also reported that *P. falciparum* is the most prevalent malaria parasite in sub-Saharan Africa, accounting for 99% of estimated malaria cases in 2016. In agreement with the current study, retrospective study results in Raya Azebo District of Tigray Region and Tselemti Wereda of Amhara Region in Ethiopia revealed that *P. falciparum* was the most

dominated species with rate of 56.9% and 58.2% respectively [21, 18]. Another study conducted in Oromia also found higher *P. falciparum* (51.5%) prevalence rate as compared to *P. vivax* (32.3%) in the study area [22]. In this study, 8.1% of mixed malarial infection of both *P. falciparum* and *P. vivax* was found. This was higher than previous studies [23, 21] and indicates co-existence of the two species which jeopardize the livelihood of the community in the area.

The study also determined that there was no statistically significant difference between male and female to be infected with malaria in ADD ($p>0.05$). The previous studies in Ethiopia, however, reported that malaria infections are more common in male than in female [21, 19, 17]. The age groups > 15 years were more affected followed by individual with age between 5 and 15 years. Children less than five years were the least affected age group in the current study area. In this regard, the finding was in line with the findings from Kola Diba of Amhara Region [10], Kersa of Oromia [24], Tselemti Wereda of Tigray Region [21] and Wolaita Zone, [25] in Ethiopia. This could be because people in this age group are involved in agricultural activities that may require spending outdoors during peak biting activities of mosquitoes to sustain livelihood of the family. Besides, they might prefer to offer mosquito nets for the sake of the wellbeing of their family members mainly for children and pregnant women [24]. However, contradictory results were reported in Arsi Negelle and Metema, Ethiopia [23, 26].

The current study determined that there was seasonality in distribution of malaria in the study area that the summer and spring seasons were the time when malaria prevalence was peaked than other seasons. These results would be expected because malaria is seasonal in Ethiopia and occurs in spring and summer coinciding with the rainy seasons [18].

The current study also revealed that IRS and LLINs coverage in the study area had been increasing over the five years at coverage rate of 34.42% and 58.35% households respectively. As the result malaria had been decreasing by 10.84% within the five years in the district. In agreement with the current study, previous reports stated that the increasing coverage of IRS and LLINs interventions have significantly impacted on malaria in Ethiopia [15, 27]. However, the prevalence of active malaria transmission in all of the studied year regardless of the maximum coverage rate IRS (80.23%) and LLINs (85.03%) evident that more efforts may be needed to eliminate the disease from the area.

5. Conclusions

The prevalence of malaria in Abe Dongoro district showed a consistent declining trend from the year of 2015-2019 coupled with increasing coverage rate of IRS and LLINs over the five years. This implies the potential towards malaria elimination with universal coverage of IRS and LLINs in study setting. The predominant malaria parasite in the study localities was *P. falciparum* followed by *P. vivax*. Results also show that age, season and kebele were the risk factors for the prevalence of the disease in the study area. Therefore, universal coverage of IRS and LLINs should be reinforced particularly targeting *P. falciparum* and *P. vivax* malaria control and elimination in the study area.

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