

ASSESSMENT OF MALARIA BURDEN AND CONTROL STRATEGIES IN ETHIOPIA

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Abstract

Malaria remains a pressing public health concern in Ethiopia, influenced by diverse factors such as climate, geography, socioeconomic conditions, and healthcare infrastructure. This study assesses the burden of malaria and the effectiveness of control strategies in Gimbie, West Wollega Zone, Ethiopia, over the past decade. Data from Gimbie Adventist Hospital's records and a cross-sectional study involving 384 participants were analyzed. The retrospective analysis of hospital records revealed an overall malaria prevalence of 45.7% within the ten-year study period. Notably, malaria prevalence fluctuated, with a peak in 2011 (11.7%) and a low point in 2013 (8.5%). The high prevalence in 2011 might be attributed to decreased attention to control measures during that period. *Plasmodium falciparum* predominated (49.9%), followed by *Plasmodium vivax* (43.6%) and mixed infections (6.5%). Gender and age significantly influenced malaria prevalence, with males (65.7%) and the age group of 16-30 years (48.1%) being the most affected. Risk factors included inadequate use of insecticide-treated nets (ITNs), indoor residual spraying (IRS), absence of window screens, and proximity to stagnant water bodies. Despite awareness of malaria transmission dynamics, knowledge alone did not correlate significantly with malaria prevalence. Only 8.5% of respondents consistently used ITNs, and 4.6% employed IRS. Most alarming was that 82.3% of respondents contracted malaria even after adopting preventive measures. This study underscores the need for sustained and comprehensive malaria control efforts, especially among young adult males, by improving access to and adherence to control interventions, enhancing public awareness, and bolstering healthcare infrastructure to achieve sustainable reductions in malaria transmission.

1. Introduction

Malaria is a disease caused by protozoan parasites belonging to the genus *Plasmodium*. The five species of the parasite known to cause disease in humans are *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale* and *P. knowlesi*. *P.*

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falciparum and *P. vivax* account for more than 95% of the cases of malaria in the world and *P. knowlesi*, whose usual host is the Kra monkey, has been found endemic in humans in parts of South-East Asia [1]. Malaria is transmitted by the bite of infective female Anopheles mosquitoes [2]. It is a major human health threat in tropical and subtropical regions of the world [3, 4]. Malaria kills about 1 million people each year [5]. In 2018, there were about 405000 deaths from malaria globally, compared with 416000 estimated deaths in 2017, and 585000 in 2010 [6]. About 90% of all malaria deaths in the world occur in Africa, south of the Sahara [7, 8].

Malaria constitutes a major public health problem and impediment to socioeconomic development in Ethiopia. It is estimated that about 75% of the total area of the country and 65% of the population is estimated to be at risk of infection [9]. *P. falciparum* accounts for about 60% of the cases of malaria and *P. vivax* accounts for about 40% [10]. The switch from the previously predominant *P. vivax* to *P. falciparum* has been reported in some areas of Ethiopia [10, 11].

In Ethiopia, malaria control has an integrated approach that is vector control with long lasting Insecticide Treated Nets, Insecticide Residual Spray, early diagnosis and treatment, environmental modification and education that help to reduce malaria [12]. The major clinical features of malaria include, severe anemia due to reduced production and increased destruction of RBCs, cerebral complications due to micro-vascular obstruction in the brain, which causes impaired consciousness, convulsions and long term neurological deficits metabolic acidosis, reduced tissue perfusion, hypoglycaemia, hypoxia due to respiratory distress and pulmonary pathology and placental infection during pregnancy [13]. Whereas severe headache, fever, vomiting, sequestration of RBCs, anemia and loss of appetite are the clinical features of uncomplicated malaria [13, 14].

According to 2008 Gimbie Adventist Hospital report, 55% of the patients tested for suspected malaria had positive results. Although zonal information on prevalence of malaria and infection among patients has gradually been increasing, in Gimbie, there is no documented information on prevalence of malaria and infection among patients in Gimbie Adventist hospital. According to records from health facilities, there are year round infection among patients and seasonal malaria in the hospital. However, despite the existence of malaria and variety of health problems, community based studies on prevalence of malaria was not carried out in Gimie. Besides, even though, several studies have been done in rural Ethiopia to assess the knowledge, attitude and practice (KAP) about malaria, there has not been much effort to carry out similar study in urban Ethiopia including Gimbie Adventist Hospital. Accordingly, the objective of this study is to assess the prevalence of malaria infection and associated factors among patients attending Gimbie Adventist Hospital during the study period.

2. Materials and Method

2.1. Description of the Study Area

The study was conducted in Gimbie Adventist hospital, West Wollega, Oromia Regional state, in Ethiopia. Gimbie town is 444 kms from Addis Ababa. The town is found within the altitudinal ranges between 1500 to 2500m above sea level. It was one of the 22 Districts of the West Wollega Zone of Oromia Region which was geographically located between 8° 43' N latitude and 10° 04' E longitudes. June to September is the main rainy season and October to November the small rainy season. It has wet climatic condition with annual rainfall of 311mm to 525.2mm and its annual temperature is 10°C to 21.33°C the average annual temperature being 17.67°C. According to the 2007 national census, the population of the District was 81,375 of which 44,303 were males and 37,072 were females. In the town there were health facilities that provide health care; these were 2 central referral hospitals, 1 health center and 5 clinics. Every Kebele had at least one health extension worker who was assigned to provide home-to-home health service to the community. According to the clinical records from the hospital, malaria infections were common in the town. Hence, malaria prevention and control interventions were being implemented. These included annual indoor residual spray (IRS), distribution of Long Lasting Insecticidetreated

bed net (ITNs/LLINs) in selected areas and prompt treatment of malaria cases using ACT-Coartem as a first line treatment based on Rapid Diagnostic Tests (RDTs). Moreover, there had been malaria infection among patients based on targeted segment of the community from selected patients based on clinical report of the diseases. This had been carried out with the support of the Government services for malaria infection diseases.

2.2. Study Design

The design of the study was a patient based cross-sectional study, which was conducted on prevalence of malaria infection among patients visiting Gimbie Adventist hospital, during the period between March 1 and June 30, 2017. For this study, 384 malaria suspected patients were selected by simple random sampling method for blood smear test attending Gimbie Adventist hospital within study period of time. To conduct the study, the questionnaire were also prepared and distributed for respondents to get relevant information about the prevalence and associative risk factors of malaria.

The data collected for this research were both quantitative and qualitative in nature. Qualitative data was used to supplement and to fill gaps during the quantitative data collection process. Hence, both primary and secondary data were used. Secondary data was used to get number of malaria infected patients of the study area and it was obtained from unpublished documents of Gimbie Adventist hospital office. Primary data was obtained from the collection of blood sample of 384 malaria suspected patients and questionnaire survey.

2.3. Data Collection Tools

Data was collected using the following methods: structured questionnaire, secondary data and the results of blood sample test for *Plasmodium* species.

Questionnaires: The structured questionnaire was used to collect data. To conduct the study, twenty (20) closed ended questions were prepared and the questionnaires were translated to Oromiffa and re-translated back to English to make the reliability of the instrument. The questionnaire included the following information: age, sex, health service facility, knowledge about malaria, the practices of utilization of ITNs and residual spray, mode of transmission, control and prevention and also to identify associated risk factors of malaria at the study area.

Blood sample test: Thick blood sample was collected from 384 malaria suspected patients and analyzed to determine the prevalence of malaria infection among the patients in Gimbie Adventist Hospital in laboratory facilities. Thick blood films were taken as positive if one or more plasmodium parasites are observed; and no hemoparasites if no parasites were seen after examining 100 high power fields. It was used to determine the prevalence of malaria and identify *plasmodium* species in terms of age and sex.

Secondary data (Retrospective study design): The data was obtained from medical records of Gimbie Adventist Hospital during January 2006 to end of January 2016 to assess the prevalence of malaria infection among patients in terms of age and sex in the study area.

2.4. Source and Study Population

2.4.1. Source of Population

The population included all malaria suspected patients infected by disease in the study area for medical purpose starting from March 1, 2017 to the end of June 2017.

2.4.2. Study Population

Members of the all malaria suspected patients attending Gimbie Adventist hospital were the source of the study population for the questionnaire and parasitological blood film. Final sample size that was included in the study was 384 patients.

2.4.3. Inclusion Criteria

All malaria suspected patients who attended Gimbie Adventist hospital within March 1, 2017 to the end of June 2017 for blood smear test.

2.4.4. Exclusion Criteria

For questionnaire, community members who were mentally handicapped and individuals who were taking antimalarial therapy or who had been treated with anti-malarial drugs within the past 4 weeks were excluded from the study.

2.5. Sample size Determination and Sampling Techniques

2.5.1. Sample Size

The sample size was determined to be all blood tested patients starting from March 1, 2017 to the end of June 2017. During this period, a total of 384 patients were included in this study. The sample size was determined using single population proportion formula of [Cochran \[15\]](#). These were:

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

Where: n = is desired sample size

$Z^2_{1-\alpha/2}$ = is the standard normal deviate at the required (95%) confidence interval (1.96)

P = is 0.5 (probability of the target population to be included in the sample)

d = is the level of statistical accuracy (margin of error) set usually at 0.05

Therefore the value of $n = Z^2_{1-\alpha/2} P(1-P)/d^2 = 1.96^2 * .50(1-.50)/.05^2 = 384$.

2.5.2. Sampling Technique

According to this, 384 malaria suspected patients attending Gimbie Adventist hospital within study period of time for blood smear test were selected by random sampling method for blood test examination. Blood sample was collected to prepare thick and thin blood film smears. Then thin smear was fixed by methanol and stain both thin and thick blood film smears in Giemsa staining (1:50 dilution) solution. Finally, the dried blood films were examined under microscope with 100x oil immersion. Species identification was done. The researcher collected and examined a blood sample twice in a week randomly within a study period to determine the prevalence of malaria, *plasmodium* species in terms of age and sex and the researcher add another 130 respondents (prospective) from patients for questionnaire administration.

2.6. Variables of the study and Measurement

2.6.1. Dependent Variables Dependent variables included knowledge about the prevalence of malaria, patient's attitude on malaria transmission and practices to prevent malaria; purpose of DDT spraying (Indoor residual spraying), INTs use and medication for malaria, mosquito nets, and smear test.

2.6.2. Independent Variables

Independent variables included socio-economic characteristics such as; age, sex, marital status, education status, and housing condition and breeding site of mosquito.

2.6.3. Data Analysis

Statistical analysis was carried out using SPSS version 20 software. Descriptive statistics was used to give a clear picture of population characteristics such as age, sex, and the distribution of *plasmodium* species. Data was represented by the percentage, frequency, and tables. Chi-square test was calculated to determine the association of some socio-demographic characteristics such as age, sex, ITNs use, usage of residual spray, and level of education with the prevalence of malaria parasite in the study participants. Statistical significance was defined at P-values less than 0.05 ($P < 0.05$).

2.6.4. Ethical Consideration

Before conducting the survey, discussion was undertaken with the head of the office of Gimbie Adventist hospital on the purpose of the study and then the study patients were asked for consent. Then, based on their consent data was collected from each selected blood sample of patients. All data collected from the individual respondents is kept confidential. Finally, treatment and advice were provided to those malaria positive during smear test by

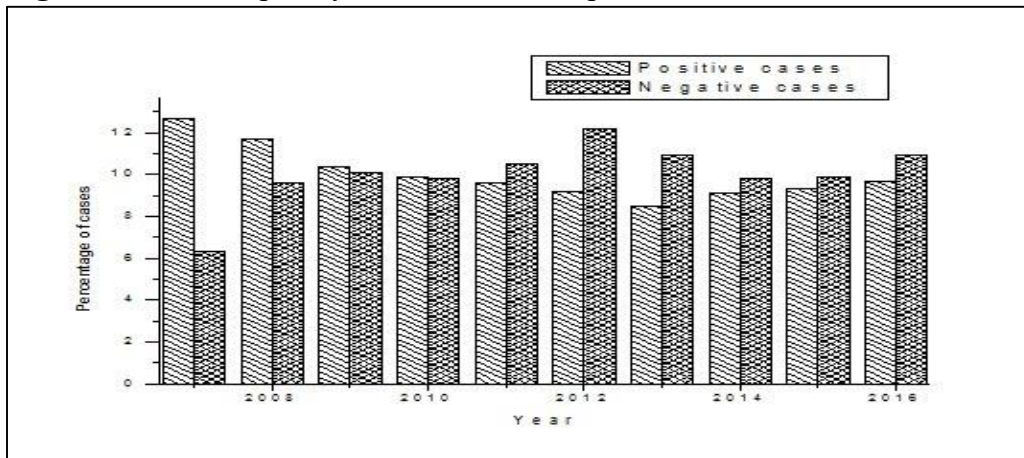
nearest health sector and hospital. At the end of this study, the study result was also been given to the Gimbie Adventist hospital.

3. Results and Discussion

3.1. Annual Trends of Malaria Prevalence

Within the past ten years (2007-2016) a total of 48208 patients visited in Gimbie Adventist hospital for malaria cases. Out of 48208 patients, 22053 were positive cases and 26155 were negative cases. The overall prevalence of malaria was 45.7% within the last ten years. The minimum percentage being reported in 2013(8.5%) and with maximum percentage being reported in 2007(12.7%) following by 2008(11.7%), 2009(10.4%), 2010(9.9%), 2016(9.7%), 2011(9.6%), 2015(9.3%), 2012(9.2%) and 2014(9.1%) respectively. Generally, prevalence of malaria reached peak in 2007 accounted for 12.7% of the total (Figure 1).

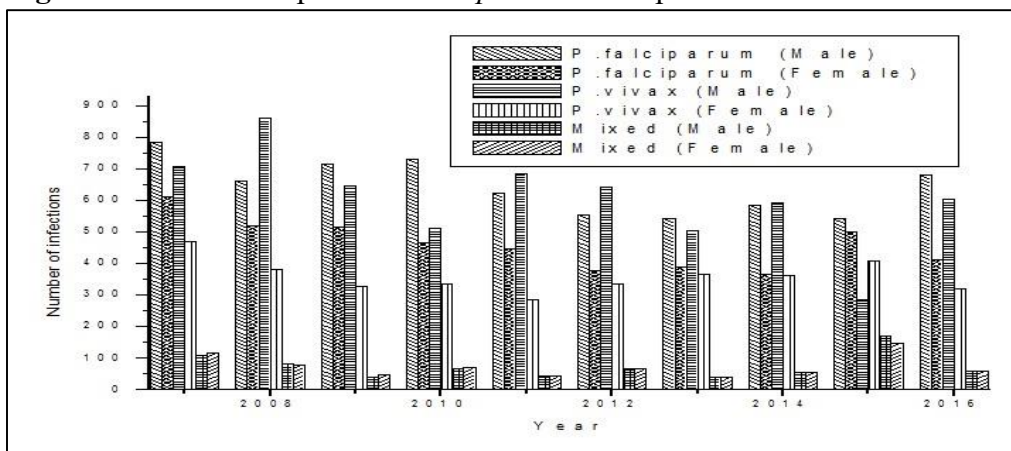
Figure-1. Microscopically confirmed annual prevalence of malaria cases in Gimbie Adventist hospital



According to the document recorded in the hospital, the identified plasmodium species were *Plasmodium falciparum* and *Plasmodium vivax* reported within each year. In the *Plasmodium* parasite species the *P. falciparum* being the predominant species of the study area and accounted for 11008(49.9%) and *p. vivax* accounted for 9611(43.6%) of malaria prevalence within the study area where as mixed cases account for 1434(6.5%).

The minimum percentage of *P. falciparum* was reported in 2012(45.7%) the maximum percentage being reported in 2007(49.9%). On the other hand, the minimum percentage of *P. vivax* (33.8%) was reported in 2015 the maximum percentage (48.1%) being reported in 2008. But, *p. vivax* was greater than *P. falciparum* only in 2008 (48.1%) and 2012 (48.1%). Mixed cases were very low throughout the study period (Figure 2).

Figure-2. The Annual prevalence of *plasmodium* species that is confirmed in Gimbie Adventist hospital



3.2. Prevalence of Malaria Parasites in Relation to Sex and Age Group

According to the record in the past ten years in the study area, males were more affected than females by malaria parasites with rate of 59.7%(13169) and 40.3%(8884), respectively. The lowest malaria infections of males were recorded in 2015 with prevalence of 51.5% (1056) and the highest malaria infection of males were recorded in 2008 with prevalence of 62.1% (1600) followed by 2007(57.2%), 2016(63%), 2013(70.9%), 2010(60%), 2009(56.7%), 2012(61.9%), 2014(61.2%), and 2011(54.2%). The highest malaria infection of females were recorded in 2007 (42.8) and the lowest were in 2013 (29.1) (Table.1).

Table-1. Annual prevalence of malaria between male and female

Year	No of infected	Sex			
		Male	%	Female	%
2007	2793	1598	57.2	1195	42.8
2008	2576	1600	62.1	976	37.9
2009	2290	1299	56.7	991	43.3
2010	2174	1305	60	869	40
2011	2119	1148	54.2	971	45.8
2012	2035	1259	61.9	776	38.1
2013	1878	1332	70.9	546	29.1
2014	2009	1230	61.2	779	38.8
2015	2049	1056	51.5	993	48.5
2016	2130	1342	63	788	37
Total	22053	13169	59.7	8884	40.3

Malaria was reported in all age groups in the study area but the age group 16-30 years olds were more affected with the prevalence of 31.5% followed by 31-45(24.9%), 0-15(18.7%), 46-60(16.3%) and above 61 years old were less affected with prevalence of 8.6% (Table 2).

Table-2. Prevalence of malaria in Gimbie Adventist hospital by age group and study years

Year	Age groups										Total
	0-15	%	16-30	%	31-45	%	46-60	%	>61	%	
2007	408	14.6	822	29.4	670	24	568	20.3	325	11.6	2793
2008	495	19.2	815	31.6	600	23.3	476	18.5	190	7.4	2576
2009	404	17.6	777	33.9	503	22	452	19.7	154	6.7	290
2010	435	20	661	30.4	556	25.6	313	14.4	209	9.6	2174
2011	422	19.9	674	31.8	519	24.5	259	20.3	245	11.6	2119
2012	416	16.3	620	32	586	30.3	256	13.2	157	8.1	2035
2013	318	16.9	684	36.4	468	24.9	257	16	151	8	1878
2014	402	20	624	31.1	506	25.2	318	15.8	159	7.9	2009
2015	413	20.2	616	30.1	512	25	310	15.1	198	9.7	2049
2016	407	19.1	662	31.1	564	26.5	388	18.2	109	5.1	2130
Total	4120	18.7	6955	31.5	5484	24.9	3597	16.3	1897	8.6	22053

Source: Secondary data (malaria cases recorded document from Gimbie Adventist Hospital)

3.3. Result Obtained from Blood Sample Tested Patients Attending Gimbie Adventist Hospital

From the total of 384 patients examined their blood and suspected to have malaria in Gimbie Adventist Hospital were participated, 199 (51.8%) were males and 185 (48.2%) were females. Table 3 below shows that, out of 384 patients 108(28.1%) were positive and the highest cases of malaria were observed in males than females by malaria parasites with rate of 71(65.7%) and 37(34.3%), respectively. The highest malaria infection of males were in June with prevalence of 44(11.5%) followed by May 33(8.6%), April 19(4.9%), March 12(3.1%). The association between sex and the prevalence of malaria was also observed and the results were statistically significant ($X^2=15.4$, $P=0.000$, $df=1$). Generally, malaria prevalence peak was observed in June 44(11.5%) and lowest in March 12(3.1%) in 2009 (Table 3).

Table-3. Distribution of *plasmodium* species between males and females from March to June in 2009 E.C

Month	Sex				Total	
	M	%	F	%	No	%
No of examined	199	51.8	185	48.2	384	100
No of infected	71	65.7	37	34.3	108	28.1
March	10	83.3	2	16.7	12	3.1
April	13	68.4	6	31.6	19	4.9
May	21	63.6	12	36.4	33	8.6
June	27	61.4	17	38.6	44	11.5

Regarding the identified plasmodium species, from the total 384 patients, 58 (53.7%) were positive for *P. falcifarum* and 34 (31.5%) for *p. vivax* and the remaining 16(14.8%) showed mixed of them. The minimum percentage of *P. falcifarum* observed in March 7(6.5%) and maximum percentage observed in June 23(21.3%) and the minimum percentage of *P. vivax* observed in March 4(3.7%) and maximum percentage observed in March and June 14(13%). In the four study months *P. falcifarum* was greater than *P. vivax* and the minimum percentage of mixed cases was also observed in March 1(0.9%) and maximum percentage observed in June 7(6.5%) within months of the blood sample tested. From this, the more participated and risked malaria patient was malaria *P. falcifarum* species (Table 4).

Table-4. Distribution of *plasmodium* species in Gimbie Adventist hospital from March to June in 2009 E.C

<i>P. species</i>	Sex	No of infected within months				
<i>P. falcifarum</i>		March	April	May	June	Total
	M (%)	6(5.6)	7(6.5)	11(10.2)	14(13)	38(35.2)
	F (%)	1(0.9)	4(3.7)	6(5.6)	9(8.3)	20(18.5)
	T(%)	7(6.5)	11(10.2)	17(15.7)	23(21.3)	58(53.7)
<i>P. vivax</i>	M(%)	3(2.8)	4(3.7)	8(7.4)	8(7.4)	23(21.3)
	F(%)	1(0.9)	1(0.9)	3(2.8)	6(5.6)	11(10.2)
	T(%)	4(3.7)	5(4.6)	11(10.2)	14(13)	34(31.5)
Mixed	M(%)	1(0.9)	2(1.9)	2(1.9)	5(4.6)	10(9.3)
	F(%)	-(-)	1(0.9)	3(2.8)	2(1.9)	6(5.6)
	T(%)	1(0.9)	3(2.8)	5(4.6)	7(6.5)	16(14.8)
Total	T(%)	12(3.1)	19(4.9)	33(8.6)	44(11.5)	108(28.1)

The number of malaria cases during the period from March to June 2009 was classified under five age groups, 0-15 years, 16-30 years, 31-45, 46-60 and greater than 61 years old. Malaria infected all age groups but the age groups of 16-30 years olds were more affected with prevalence of 48.1% followed by 31-45, 0-15, 46-60, and

greater than 61 years age groups, with prevalence rates of 30.6%, 12%, 8.3% and 1%, respectively. The greatest number of malaria cases was tested in the age group of 16-30 years old (48.1%). The association between the prevalence of malaria and the age groups were found to be statistically significant ($X^2=48.28$, $p=0.000$, $d=8$) (Table 5).

Table-5. Prevalence of malaria in Gimbie Adventist hospital related to age groups and months

Month	Age groups										Total	%
	0-15	%	16-30	%	31-45	%	46-60	%	>61	%		
March	2	16.7	6	50	3	25	1	8.3	-	-	12	11.1
April	4	21.1	8	42.1	5	26.3	2	10.5	-	-	19	17.6
May	2	6.1	17	51.5	12	36.4	2	6.1	-	-	33	30.6
June	5	11.4	21	47.7	13	29.5	4	9.1	1	2.3	44	40.7
Total	13	12	52	48.1	33	30.6	9	8.3	1	1	108	100

Source: Own survey data

3.3.1. Comparison of Prevalence of Malaria in Terms of Sex

Comparison of malaria cases detected from the results of recorded data and a blood sample was the same on the males and shown high in both study period of time. In males the percentage of malaria prevalence was slightly increased (59.3% to 65.7%) and females were decreased (40.3% to 34.3%) (Table 6).

Table-6. Comparison of sex specific malaria infections in the study area

Sex	The study period			
	2007-2016		March, 2017-June, 2017	
	No	%	No	%
Male	13169	59.7	71	65.7
Female	8884	40.3	37	34.3

3.3.2. Comparison of Prevalence of Malaria in Terms of Age Groups

Comparison of malaria cases detected from the results of recorded data and a blood sample tested shows that malaria affected all age groups in both study period of time, but the age group of 16-30 years olds were more affected in both 2007-2016 and 2017 with the prevalence of 31.5% and 48.1% respectively. Generally, on the age groups of 16-30 and 31-45 years olds the malaria prevalence has increased in 2017 study periods of time. However, on the age groups of 0-15, 46-60, and >61 year olds prevalence has decreased significantly (Table 7).

Table-7. Comparison in age groups of malaria infections between the result obtained from recorded data (2007-2016) and a blood sample test (March-June)

Age groups	The study period			
	2007-2016		March, 2017- June, 2017	
	No	%	No	%
0-15	4120	18.7	13	12
16-30	6955	31.5	52	48.1
31-45	5484	24.9	33	30.6
46-60	3597	16.3	9	8.3
>61	1897	8.6	1	1

3.4. Socio-Demographic Characteristics of the Study Participants in the Study Area

Summary of some of socio-demographic characteristics of the study participants are presented in [Table 8](#). From the 130 individuals who were planned for participation, 55(42.3%) were males and 75(57.7%) were females. In the all respondents the age groups of 0-15 years olds were 21.5%, 16-30 years olds were 43.1%, 31-45 years olds were 20%, 46-60 years olds were 13.1% and greater than 61 years olds were 2.3% respectively. Regarding their educational level: About 109 (83.8 %) primary education, 18(13.8 %) secondary education, and 3(2.3 %) had higher education (college).

Table-8. Socio-demographic characteristics of patients in the study area

No	Demographic	No	%
1.	Sex		
	Male	55	42.3
	Female	75	57.7
2.	Age groups(years)		
	0-15	28	21.5
	16-30	56	43.1
	31-45	26	20
	46-60	17	13.1
	>61	3	2.3
3.	Educational level		
	Primary	109	83.8
	Secondary	18	13.8
	College	3	2.3

3.5. Respondents' Attitude and Practices Towards Malaria Control and Prevention Measures

From the total of 130 respondents, 108(83.1%) were infected with malaria. Among this, 79(60.8%) were moved to other malarious areas before that week and all infected 108(83.1%) were taken anti-malaria treatments. Out of all participants only 11(8.5%) used mosquito control and preventive measures of which 4(3.1%) were used ITNs and 6(4.6%) were used IRS. 107(82.3%) of the respondents contracted malaria even after they started to use ITNs or IRS and only 13(10%) of the respondents were used ITNs throughout the year. Again, from the suggestion of the participants 74(56.9%) were not kept cattle out-door at night. 7(5.4%) participants revealed that there were stagnant water around their house and 127(97.7%) were drained it rapidly. Almost all-103(79.2%) respondents indicated that they did not use windows screened with mosquito wire mesh in their houses. Regarding the awareness of respondents, 102(78.5%) said that the major cause of malaria was malnutrition and the suggestion of 8(6.2%) respondents were malaria could be transmitted by eating meal together while 106(81.5%) indicated that causative agent of malaria was mosquito ([Table 9](#)).

Table-9. For optional questions of patients in studied hospital on prevalence of malaria

No	Statements of questionnaires	Responses of patients (n=130).			
		Yes	%	No	%
1	Have you contracted malaria?	108	83.1	22	16.9
2	Have you been moved to other malarious areas before this week?	79	60.8	51	39.2
3	Did you take anti-malaria treatment (drug)?	108	83.1	22	16.9
4	Have you used mosquito control and preventive measures?	11	8.5	119	91.5
5	Do you use ITNs to control and prevent the biting of mosquito?	90	69.2	40	30.8
6	Is there IRS to your home to combat the spread of malaria?	16	12.3	114	87.7

7	Have you contracted after bed net or IRS use?	108	83.1	22	16.9
8	Use ITNs throughout of the season of the year	13	10	117	90
9	Keep cattle out-door at night?	56	43.1	74	56.9
10	Is there stagnant water surrounding your house?	97	74.6	33	25.4
11	If yes, do you drain it rapidly?	127	97.7	4	3.1
12	Do you use window screen in your house?	27	20.8	103	79.2
13	The major cause of malaria is malnutrition?	85	65.4	45	34.6
14	Malaria can be transmitted by eating meal together?	122	93.8	8	6.2
15	Is mosquito the causative agent of malaria?	106	81.5	24	18.5

3.6. Some of the Risk Factors Associated with the Prevalence of Malaria Infection among Patients

The association between the prevalence of malaria and the use of ITNs/LLITNs was statistically significant ($P=0.001$). Also, the association between the prevalence of malaria and the use of IRS was statistically significant ($P=0.019$). But, the association between the prevalence of malaria and the awareness of patients on the causes of malaria was not statistically significant ($P=0.850$) (Table 10).

Table-10. Chi-square risk factors associated with the prevalence of malaria infection among patients

No	Variables	categories	Total	Positive	Negative	X ²	Df	p-value
1	Do you use ITNs to control and prevent the biting of mosquito?	Yes	90	68	22	11.8	1	0.001
		No	40	40	0			
2	Is there IRS to your home to combat the spread of malaria?	Yes	16	10	6	5.5	1	0.019
		No	114	98	16			
3	Is there stagnant water surrounding your house?	Yes	97	87	10	11.9	1	0.001
		No	33	21	12			
4	Do you use window screen in your house?	Yes	27	16	11	13.8	1	0.000
		No	103	92	11			
5	The major cause of malaria is malnutrition?	Yes	85	71	14	0.036	1	0.850
		No	45	37	8			

4. Discussion

Malaria has been one of the major public health problems in many developing countries including Ethiopia, depending on the climatic conditions, geographical location, seasonal variation, and socio economic pattern of the population, varying degree of prevalence of malaria infection was reported from different studies [16].

First, this study was conducted on the prevalence of malaria infection among patients in Gimbie Adventist hospital within the past ten years from unpublished documents of the hospital. In the present study, the overall prevalence of malaria was 45.7% within the last ten years. The analysis of data record from Gimbie hospital showed that malaria prevalence was reduced in 2013(8.5%) compared to that in 2007 (12.7%). This might be due to the control intervention measures (supply of sufficient INTs, anti-malarial sprays, etc) taken following the 2013 malaria epidemic. Also, the malaria prevalence was high in 2011(11.7%) compared to that in 2013(8.5%). The reasons for malaria increased during this period might be due to less attention to malaria control and preventive activities by different responsible bodies, lack of awareness of the community on use of ITNs, insufficient budget for malaria control and prevention activities.

Majority of the cases recorded in the study area was *P. falciparum* (49.9%) and the next *p. vivax* (43.6%) and mixed (6.5%), which was in contrast with the study conducted around Butajira, southern Ethiopia, where the

prevalence of *P. falciparum*, *P. vivax* and both of them were shown to be 12.4%, 86.5% and 1.1%, respectively [17]. This may be due to climatic conditions and geographical location. Majority of the cases recorded in the present study were due to *P. falciparum* (49.9%), which was similar with most other reports [18-20].

The prevalence of malaria in case of sex, males were more affected than females by malaria parasites with rate of 59.7% and females were 40.3%. The reason why malaria affected productive age groups (16–30) and more males might be due to the fact that in Gimbie, agriculture is the main occupation and to keep the cattle and grain staying outside the home and sleeping in hut is common during the night time. Due to these different reasons, they exposed to anopheles mosquito bites, which can transmit malaria parasites.

Again, across-sectional study was conducted on prevalence of malaria infection among patients attending at Gimbie Adventist hospital based on cross-sectional study within four months (March, April, May, June) and three hundred eighty four (384) blood samples were collected from malaria suspected patients. The overall prevalence of malaria infection in the study area was 28.1%. The overall prevalence of malaria parasite infection in this study was higher than previous national and regional malaria prevalence reports of USAID/CDC (2010) which was 0.7% in Ethiopia and 0.3% in Oromia, respectively. The observed differences might be due to nature of study settings, seasonality of malaria, method of detection and the places location.

In this study *Plasmodium falciparum* infection was highly prevalent than *Plasmodium vivax*. It showed that 58(53.7%) were *Plasmodium falciparum*, 34(31.5%) were *plasmodium vivax* and 16 (14.8) were mixed infection. The prevalence of malaria in this study is complimentary to the study done in Assendabo teaching health center in 2003 where malaria causes were diagnosed and treated. The prevalence of *P. falciparum* is 32(51.6%) with 12(7.8%) mixed infection which show that the dominance of *P. falciparum* was similar to this study [21]. But, this study was different from the study conducted at Aletawondo in 2007 on 185 study subjects which indicates that 68(66%) were *Plasmodium vivax* and 35(34%) were *P. falciparum* infection from 103(55.7%) positive cases [12]. This may be due to difference in the study period, sample size used, study area and other factors.

The study conducted in this area showed that high malaria prevalence was detected in a Month of June within four months (March, April, May, June). This may have been due to the malaria transmission in Ethiopia is generally seasonal and highly unstable due to variations in topography and rainfall patterns. Marked variations in the level of transmission from place to place or seasonal fluctuations in the number of cases are the main features of malaria transmission in Ethiopia [22].

There was also association between sex and age group with prevalence of malaria. The highest cases of malaria were observed in males (65.7%) than females (34.3%). It was much higher than that reported in Kersa Woreda, Jimma district, Bangladesh which was 43.8% and 15.25%, respectively [18, 19]. The observed differences might be due to nature of study settings, seasonality of malaria, and method of detection.

The highest to the lowest pattern of prevalence of malaria was seen as 16-30>31-45>0-15> 46-60>61 age groups. Moreover, higher prevalence was seen in males of 16-30 age group year (48.1%). But, only a few prevalence of malaria parasite infection was seen among individuals of >61 age group years (1%). This was consistent with the findings reported in Kersa Woreda, Jimma [18]. This might be due to greater exposure of males of age group 16-30 years to the mosquito vectors due to outdoor activities during night. In contrary to the present study, Adugna, et al. [23] reported more prevalence of malaria infections in young aged groups than adult individuals in Butajira area. This might be due to the fact in the present study area that many adult males are working in outdoor activities during night which increases the risk for mosquito bites.

Furthermore, there was discrepancy between the retrospective annual overall malaria prevalence (45.7%) based on clinical record from Gimbie Adventist hospital, and the prevalence (28.1%) of malaria from the present study based on a cross-sectional study. The existence of discrepancy between the retrospective and cross-sectional

prevalence values is a well-established phenomenon and has been reported in different malaria epidemiological studies. For instance, a study conducted in malaria prevalence in the community of Mekong Delta region showed that the retrospective malaria prevalence (62%) is higher than the cross-sectional malaria prevalence determination (2.4%) in the same survey period [24]. This study can be explained by the fact that the clinical records are based on patients that have been recorded to the hospital for seeking treatment while the cross sectional study is based on random sampling blood tests of malaria suspected patients. Generally, the prevalence of malaria was high on both study period in the same age groups (16-30) and sex (males).

In the socio-demographic characteristics of the study participants, Out of 130 research participants, 55(42.3%) were males and 75(57.7%) were females. From the total of 130 respondents, 108(83.1%) were positive and the highest cases of malaria were observed in males than females by malaria parasites with rate of 71(65.7%) and 37(34.3%), respectively.

Out of all participants only 11(8.5%) used mosquito control and preventive measures of which 4(3.1%) were used ITNs and 6(4.6%) were used IRS. Then, 107(82.3%) of the respondents contracted malaria even after they started to use ITNs or IRS and only 13(10%) of the respondents were used ITNs throughout the year. Thus, in reference to the national strategic plan of the Federal Ministry of Health which aims to attain a coverage of 60% with at least two ITNs by 2007 FMH [25], the coverage in the study area could be considered low. In this study usage of ITNs, IRS, window screen and the stagnant water were associated risk factors with malaria distribution.

Again, from the suggestion of the participants 74(56.9%) were not kept cattle out-door at night. 7(5.4%) participants revealed that there were stagnant water around their house and 127(97.7%) were drained it rapidly. Almost all 103(79.2) respondents indicated that they did not use windows screened with mosquito wire mesh in their houses. With respect to sex, males constitute the highest number of patients due to unused ITNs, IRS, window screen and those that live around stagnant waters were more infected by malaria.

Regarding the awareness of respondents, 102(78.5%) said that the major cause of malaria was malnutrition and the suggestion of 8(6.2%) respondents were malaria could be transmitted by eating meal together while 106(81.5%) indicated that causative agent of malaria was mosquito. The association between the prevalence of malaria and the awareness of patients on the causes of malaria was not statistically significant ($P= 0.850$). Therefore, the respondents' knowledge about malaria has no association risk factors with the prevalence of malaria.

In general, the difference in the overall prevalence and specific malaria species in this study and the study conducted at different places mentioned above might be again due to variation in the study area, period, sample size used, climatic condition, environmental factors and economic pattern of the population, difference in study subjects and other factors.

5. Conclusion

Malaria is still a major health problem in Gihmbie, West Wollega zone of Ethiopia. *Plasmodium falciparum* and *Plasmodium vivax* were unmoving predominant parasites detected. The highest peak of malaria cases was observed in 2007 and the minimum prevalence in 2009, and males are more affected than females in the study area. The high prevalence of malaria in both retrospective and cross-sectional studies was the same on the males and the age groups of 16-30 years old. The overall prevalence of malaria parasites in the study participants was 28.1 %. The majority respondents participated in survey questionnaires was between the age group 16-30 years old and their educational status was primary school. In this study, the patients were infected with malaria due to stagnant water, absence of window screen, lack of effective use of ITNs and IRS, as well as a low awareness of patients on the transmissions, control and preventive method on prevalence of malaria. The usage of ITNs, IRS, window screen and the stagnant waters were associated risk factors with malaria distribution.

References

- Cox, S. J., 2008. "Plasmodium Knowlesi malaria in humans is widely distributed and potentially life threatening." *Clin Infect Dis.*, vol. 46, pp. 165-171.
- Canbell, C. C., 1991. "Challenges facing malaria therapy in Africa." *Journal of infectious Disease*, vol. 163, pp. 1207-1211.
- Minakawa, N., Omukunda, E., Zhou, G., Githeko, A., and Yan, G., 2006. "Malaria vector productivity in relation to the highland environment in Kenya." *Am. J. Trop. Med. Hyg.*, vol. 75, pp. 448-453.
- Tilahun, B. and Befikadu, A., 2017. "Magnitude of malaria infection in chalia district, west shoa zone, Oromia regional state, Ethiopia." *Journal of Health, Medicine and Nursing*, vol. 35, pp. 65-69.
- Pierce, S. K. and Miller, L. H., 2009. "World malaria day 2009: What malaria knows about the immune system that immunologists still do not." *Immunol. J.*, vol. 182, pp. 5171-5177.
- World Malaria Report, 2019. "Regional and global trends in burden of malaria cases and deaths. World malaria report 2019."
- Abebe, A. and Bernt, L., 2018. "Use of epidemiological and entomological tools in the control and elimination of malaria in Ethiopia. Animut and Lindtjörn." *Malar J.*, vol. 17, p. 26.
- Guerra, C. A., Gikandi, P. W., Tatem, A. J., Noor, A. M., Smith, D. L., Hay, S. I., and Snow, R. W., 2008. "The limits and intensity of plasmodium falciparum transmission: Implications for malaria control and elimination worldwide." *PloS Med.*, vol. 5, p. e38.
- MOH, 2007. "Entomological profile of Malaria in Ethiopia." Available: http://www.afro.who.int/vbc/reports/entomological_ethiopia.pdf
- Ramos, J., Reyes, M., and Tesfamariam, A., 2005. "Change in epidemiology of malaria infections in a rural area in Ethiopia." *J. Travel. Med.*, vol. 12, pp. 155-156.
- Aschalew, A. and Tadesse, D., 2016. "Current status of malaria in ethiopia: Evaluation of the burden, factors for transmission and prevention methods." *Acta Parasitologica Globalis*, vol. 7, pp. 01-06.
- Milikit, D., Worede, A., molargi, T., Aboye, G., and Gebrehiwot, T., 2007. *Prevalence of malaria among patients attending in aletawondo health center*. Southern Ethiopia, pp. 13-26.
- Mackintosh, C. L., Beeson, J. G., and Marsh, K., 2004. "Clinical features and pathogenesis of severe malaria." *Trend Parasitol*, vol. 20, pp. 597-603.
- Eshetu, M. and Basha, A., 2015. "Prevalence of malaria and associated factors in dilla town and the surrounding rural areas, geddo zone, southern ethiopia." *J. Bacteriol. Parasito.*, vol. 6, p. 242.
- Cochran, W. G., 1977. *Sampling techniques*. 3rd ed. New York: John Wiley and Sons.

- Gidie, W. D. and Dejene, H. K., 2016. "Prevalence of malaria and associated factors in BennaTsemay district of pastoralist community, Southern Ethiopia." *Debo and Kassa Tropical Diseases, Travel Medicine and Vaccines*, vol. 2, p. 61.
- Aynalem, A., 2008. "Malaria in Ethiopia." p. 30. Available: [Http://www.EthioDemographyandHealth](http://www.EthioDemographyandHealth)
- Haque, U., Ahmed, S. M., Hossain, S., and Huda, M., 2009. "Malaria prevalence in Endemic Districts Of Bangladesh." *Malaria Journal*, vol. 4, pp. 1371-6737.
- Karunamoorthia, K. and Bekele, M., 2009. "Prevalence of malaria from peripheral blood smears examination: A 1 -year retrospective study from the serbo health center Kersa Woreda, Ethiopia." *Journal of Infection and Public Health*, vol. 2, pp. 171-176.
- Syafruddin, K., 2009. *Seasonal prevalence of malaria in west Sumba district, Indonesia*. Licensee BioMed Central Ltd. Indonesia.
- Tesfaye, D., 2003. "A mixed malarial infections among clinically malaria suspected patients in Assendabo teaching Health center." *Am J Trop Med Hyg.*, vol. 68, pp. 51-55.
- Yeshiwondim, A., Gopal, S., Hailemariam, A., Dengela, D., and Patel, H., 2009. "Spatial analysis of malaria incidence at the village level in areas with unstable transmission in Ethiopia." *Int. Journal Health Geographics*, vol. 8, pp. 9-85.
- Adugna, W., Teshome, G.-M., and Ahmed, A., 2013. "Malaria in Addis Ababa and its environs: assessment of magnitude and distribution." *Ethiop Journal of Public Health, Dev.*, vol. 16, pp. 147-155.
- Erhart, A., Thang, N. D., Hung, N. Q., Toi, L. V., Hung, L. X., Tuy, T. Q., Congb, L. D., M., S., Coosemans, M., *et al.*, 2004. "Forest malaria Vietnam: a challenge for control." *Am. J. Trop. Med. Hyg.*, vol. 70, pp. 110-118.
- FMH, 2007. "Annual Performance Report 2015 (HSDP IV) for EFY 2007 (2014/15) version 1, Addis Ababa, Ethiopia."