Urban malaria prevalence and its associated risk factors: the case of Batu town, East Shoa, Oromia Regional State, Ethiopia

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Research

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Abstract

Background- Malaria is one of the leading causes of morbidity and mortality particularly in sub-Saharan Africa including Ethiopia. Approximately, 68% of its population is at a risk of malaria infection and nearly three-fourth of the Ethiopia landmass is considered as malarious. Most of the malaria related researches are being conducted in the rural areas; however, urban malaria should be also targeted without which malaria elimination is impossible. Therefore, the aim of this study was to assess the magnitude of malaria, prevalence of *P. falciparum* and *P. vivax* and its associated risk factors during low transmission season (April to July, 2018) in Batu town, East Shoa, Oromia Regional state, Ethiopia.

Methods – Finger pricked blood samples were collected from 356 febrile individuals visiting health facilities in Batu town from April to July, 2018 supplemented with questionnaire survey to assess socio-demographic and risk factors associated with malaria infection.

Results – In the current study an overall prevalence of 17.13% (61/356) malaria infection was observed of which 50.8% (31/61) were positive for *P. vivax*, 45.95% (28/61) were positive for *P. falciparum* and 3.3% (2/61) were mixed infections of *P. falciparum* and *P. vivax*. Male individuals (32 (9%)) were more infected with malaria than females (29 (8.2%)). Sex had no statistical significance association with malaria ($\chi 2 = 2.026$, $P = 0.156$). Logistic regression analysis revealed that individuals who possessed ITN (OR = 0.38, 95% CI (0.194, 0.743) and $P = 0.005$) and whose houses were sprayed with insecticides (OR = 0.18, 95% CI (0.097, 0.34) and $P < 0.001$) were found less likely to get malaria infection. Individuals living closer to stagnant water had more chance (almost three-fold times) of malaria infection than those who were found at a distant from stagnant water (OR= 2.97, 95% CI (1.68, 5.26) and $P < 0.001$).

Conclusion- The current study revealed that malaria is still public health problem in Batu town, which might indicate the same in other urban areas of the country. Therefore, in order to get the national picture about the prevalence of urban malaria and its associated risk factors, we recommend large scale investigation of the situation.

Background

Malaria is a life threatening protozoan disease caused by one of the five *Plasmodium* parasites: *P. falciparum*, *P. vivax*, *P. ovale*, *P. malariae* and *P. knowlesi* and transmitted by the bites of female *Anopheles* (*An.*) mosquitoes. *P. falciparum* is the deadliest parasite in terms of its morbidity and mortality and it is the most prevalent malaria parasite in sub-Saharan Africa (SSA) accounting for 99% malaria cases in 2016, whereas, *P. vivax* is the most prevalent in Asia and South America [1]. Worldwide an estimated 219 million cases of malaria occurred in 2017 which are slightly higher in trend compared to 216 million cases of infection in 2016 in 91 countries and the global total of malaria deaths reached 435,000 deaths, compared with 451,000 estimated deaths in 2016 [1]. Mainly (90%) malaria deaths occur in SSA, where children under five years of age account for 78% for all malaria deaths [2].

Ethiopia is one of the sub-Saharan Africa mostly affected by malaria. It ranks top of the communicable infectious diseases in the country [3]. It is one of the leading causes of morbidity and mortality in Ethiopia [4]. Approximately, 68% of its population is at a risk of malaria infection [5] and nearly three-fourth of the Ethiopia landmass is considered as malarious, with malaria mainly associated with rainfall and altitude [6]. Malaria transmission is seasonal and unstable; major transmission occurs from September to December while minor transmission occurs following short rainfall from April to May [7]. In Ethiopia, *P. falciparum* and *P. vivax* are the two dominating species accounting for 60% and 40% malaria cases, respectively, reported in the country [7, 8]. However, this proportion varies from place to place and season to season [7]. For example, recent studies have showed that there is a trend of shift of dominance from *P. falciparum* to *P. vivax* [9-11]. Since 2004, arthemisinin-lumefantrine (AL) (Coartem®) and chloroquine (CQ) are used as first line drugs for the treatment of *P. falciparum* and *P. vivax*, respectively, in the country [7]. *An. arabiensis*, a member of *An. gambiae* species complex, is the main malaria vector while *An. pharoensis*, *An. funestus* and *An. nili* are secondary vectors in some areas [12, 13]. Recently, a new malaria vector, *An. stenphensi*, was detected in Ethiopia through molecular and morphological methods [14].

Compared to rural areas, urban areas are considered at low risk to malaria because of the improved housing, socioeconomic status, expanded personal protection, effective diagnosis and treatment and limited breeding sites for *Anopheles* mosquitoes [15, 16]. However, reports showed that urban malaria cases accounted for 6-28% estimated global malaria incidence [15], therefore in the era of malaria elimination urban malaria should receive due attention. Urban agricultural practices and small irrigations surrounding towns in African cities might create conducive environment for the *Anopheles* mosquitoes breeding [11, 16]. In addition most of African cities including those of Ethiopia are characterized by poor housing conditions, lack of proper sanitation and poor water drainage system which could likely increase humans and malaria vector contacts and thereby facilitate urban malaria transmission [17]. On the other hand, Ethiopia in its national malaria elimination roadmap set target to eliminate malaria by 2030 [18]. However, malaria researches in Ethiopia mainly focused on rural areas, as a result there have been scarcity of studies addressing magnitude of malaria, species distribution and associated factors in Ethiopian towns located in malarious areas including Batu town. The nature of rural areas is different in many aspects from that of urban areas. Research findings of the urban areas could help to design and implement appropriate cost-effective intervention strategies to realize malaria elimination set by the country. Therefore, the aim of the current study was to assess the magnitude of malaria, prevalence of *P. falciparum* and *P. vivax* and the associated risk factors during low transmission season (April to July, 2018) in Batu town, East Shoa, Oromia Regional State, Ethiopia. Understanding the magnitude of malaria situation and risk factors during minor transmission season enables us to deduce larger picture of malaria during major malaria transmission season. The findings of this study will augment policy makers, program managers and implementers during the design of strategies for the control and elimination of malaria in Ethiopia.

Methods

Description of study area

Batu, formerly Zeway town, is located in the central part of Ethiopia, 165 Km South of Addis Ababa, capital of Ethiopia, in the middle of Ethiopian Rift Valley (Figure 1) and described elsewhere [11]. Briefly, the town's geographical coordinates are $7^0$56'03" N latitude and $38^0$42'56" E longitude. The town is found at an average altitude of 1657m above sea level. The town has a total population of 78,784 (40,180 males and 38,604 females) in two *kebeles* (government administrative entities below district level). The town has two hospitals (one government and one private), two government health centers and eight private medium clinics (Batu town health office, 2018). In the town there are gorges, ditches, poor sanitations (tidiness) and vegetation covered areas which favour mosquito breeding conditions. Although there are also poorly constructed houses in the town, its periphery is especially characterized by such houses which could allow indoor mosquito biting during the nights. Around the town there is Lake Batu (Zeway), which covers an area of about 434Km^2 and an average depth of 4m [19]. The lake serves for fishing, recreation and irrigation of small farms. The lake area maintains malaria transmission even during dry season by creating conducive breeding ground for *Anopheles* mosquitoes at the lake shoreline [20]. The area receives between 700 – 800 mm of annual rainfall, with the heavy rains during the months of June to September and short rains in April and May. The mean temperature of four months was 22^0C; with a mean maximum and minimum temperatures of 29^0C and 15^0C, respectively (South Ethiopia District Meteorological Agency, 2018). Malaria transmission in Batu area is generally unstable (seasonal), with peak transmission occurring between the months of September and November, immediately after the main rainy season, while the second less pronounced transmission period falls between April and May in the short-rainy season. The major malaria vector in the area is *An. arabiensis* while *An. pharoensis* plays secondary role [19].

Study design

Health institution based cross-sectional study was conducted among patients from Batu town attending governmental and private health facilities from April to July, 2018. Patients suspected for malaria from the outpatient departments of health facilities were included in the study. Malaria suspected patients who came from out of the town were excluded from the study.

Sample size and Sampling Techniques

Sample size was estimated by using single population proportion formula [21], taking 95% confidence level (Cl) (Z (1-(1-ά/2) = 1.96), 0.05 margin error and 15% non-respondent rate. Prevalence was assumed to be 28.1% which was previously reported from Chichu and Wonago health centers, South Ethiopia [22]. Based on the above assumptions, the sample size was calculated as follows:

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

$$n = \frac{(1.96)^2 (0.281)(1-0.281)}{(0.05)^2}$$

$$n = 310 + 15\% (46) = 356$$

Accordingly, 356 individuals were included in the study. Study subjects were selected randomly for parasitological examination from all 12 health facilities (two hospitals, two health centers and eight private medium clinics) found in Batu town.

Blood Collection

At each health facilities, patients were first clinically diagnosed for the presence of fever at outpatient departments. Study subjects with eligible criteria were invited for parasitological examination. Febrile individuals who are older than 18 years and parents of those children less than 18 years were interviewed for socio-demographic and risk factors associated with malaria infections.

Blood collection was done according to the standard operating procedure developed by WHO [23]. Briefly, before blood collection the tip of the finger was cleaned by cotton moistened with alcohol. Using blood disposable lancet two drops of blood was taken on slide. Thick and thin blood smears were prepared on the same slide side by side. After slides were air dried on horizontal position, the thin blood smears were fixed with methanol for about 30 sec. The thick blood smears were stained with 10% Giemsa solution for 20 minutes. Blood slides were read under oil emersion objectives by experienced laboratory technologists. Parasites positivity was detected from thick blood smears while *Plasmodium* species identification was done from thin smears. For quality control blood slides were read by two technicians at each health facilities. At each health facilities laboratory technicians re-read the samples by being blind to the slide test results, no discordant results were obtained. Slides were regarded as negatives after 100 fields were carefully examined.

Ethical consideration

Ethical clearance for this research was obtained from Adama Science and Technology University Research and Ethical Committee. The aims, risks and benefits of the study were explained for the study participants. Written informed consent was obtained from the study participants and in cases of children under 18 years age assent was also obtained from their parents. Patients showing positive results for *P. falciparum* and mixed infections were treated with AL while those infected with *P. vivax* were treated with CQ according to the national malaria treatment guide line [24].

Questionnaire Survey

Structured questionnaire involving socio-demographic and risk factors associated with malarial infections was developed first in English and then translated to local language (*Afan Oromo*) and administered to voluntary study participants from whom blood was taken. Questionnaire was first explained to laboratory technicians who collected the data at each health facilities. After the purpose of the study was explained to the study participants/children's parents questionnaire was filled out during blood film collection.

Data Analysis

Collected data were entered into Microsoft Excel. The data were analyzed using SPSS version 25 (SPSS, Chicago, USA). Chi-square test statistics was conducted to determine association between age, gender, season and prevalence of malaria using 95% confidence interval and P-value. P-value < 0.05 was considered statistically significant. Descriptive statistics was used to calculate frequencies and percentages. Tables and graphs were also used to present the results. The associations of different risk factors with malaria infection were analyzed using logistic regression analysis together with their corresponding 95% confidence intervals and odds ratio.

Results

Socio-demographic characteristics of the study participants

All 356 individuals who were included in the study gave response to the questionnaire. Among study participants two-hundred sixteen (60.7%) were males where most of them were in the age groups above fourteen years old (46.90%). Educational status for most of the study respondents (24.72%) were above grade twelve and most of them (41.57%) were private (daily laborers) (Table 1).

Table 1. Socio-demographic characteristics of study subjects (N = 356) at Batu town from April to July, 2018.

Variables	Frequency	Percentage
Sex		
Male	216	60.7
Female	140	39.3
Age		
0 – 4	85	23.87
5-14	103	28.93
>14	167	46.90
Education status		
Illiterate	41	11.52
1- 4	53	14.89
5 – 8	71	19.94
9 – 10	55	15.45
11- 12	48	13.48
>12	88	24.72
Occupation*		
Merchant	95	26.69
Government employer	62	17.42
Farmer	51	14.32
Private (daily laborers)	148	41.57

*For children less than 18 years an occupation of their parents was considered.

Malaria prevalence and its associated risk factors

Out of 356 subjects involved in the current study, 17.13% (61/356) of them were confirmed malaria positive (Table 2). Variable test positivity was recorded at different health facilities which might be due to spatial heterogeneity of mosquito breeding sites in Batu town.

Table 2. Malaria cases among selected study subjects at Batu town from April – July, 2018.

Health facilities	Total number of examined subjects	Total malaria positive cases	Prevalence (%)	*Pf*	*Pv*	Mixed (*Pf* + *Pv*) infections
Share Ethiopia hospital*	52	9	17.3	4	5	0
Tsion MC	43	10	23.3	2	8	0
Meskel MC	35	7	20	3	4	0
Kidane MC	20	5	25	3	1	1
Oliyad MC	38	8	21	4	3	1
Bari MC	25	3	12	1	2	0
Addisu MC	18	1	5.6	1	0	0
Habtemu MC	31	5	16	2	3	0
Rabira MC	11	2	18.2	2	0	0
Dembel HC***	14	3	21.4	3	0	0
Batu HC***	18	2	11.1	1	1	0
Batu hospital**	51	6	11.8	2	4	0
Total	356	61	17.13	28	31	2

MC: Medium clinic, HC: health center, *Pf*: *Plasmodium falciparum*, *Pv*: *Plasmodium vivax*

* - private hospital; ** - government hospital; *** - government health centers

Of the total malaria cases identified, higher cases (50.8%, 31/61) were occurred due to *P. vivax* than *P.falciparum* (45.9%, 28/61). Mixed infections were occurred in 3.3% (2/61) of the total malaria cases (Figure 2).

With regard to the distribution of malaria cases with sex, out of 17.13% overall prevalence of malaria, we observed 9% and 8.13% in males and females, respectively (Table 3). Sex had no statistical significance association with malaria infection ($\chi 2 = 2.026$, $P = 0.155$). Malaria infection occurred among all age groups. We observed higher prevalence of malaria, 11.8%, among age groups of greater than 14 years old (adolescents and adults); whereas for age groups between 0 – 4 and 5 – 14 years old, it was 2.5% and 2.8%, respectively. There was statistically significant association between age and malaria infection (Table 3).

Table 3. Prevalence of malaria in relation to sex and age groups of study participants at Batu town from April – July, 2018.

Risk factors	Number examined	Number infected	Percentage*	P-value
Sex				
Male	216	32	9	0.156
Female	140	29	8.1	
Total	356	61	17.1	
Age groups				
0 – 4	86	9	2.5	0.001
5-14	103	10	2.8	
> 14	167	42	11.8	
Total	356	61	17.1	

*Percentage is out of total population (N= 356)

The average monthly prevalence of malaria was 16.9%. However, the number of patients visiting health facilities showed fluctuating during the months the study was conducted. Relatively greater number of malaria cases (36; 59.0%) were treated during June and July months (wet season) while lower number (25; 41.0%) during April and May months (Dry season) (Figure 3). However, there was no statistical significance difference in malaria prevalence between seasons ($\chi 2 = 3.118$, $P = 0.077$) (Table 4).

Table 4. Seasonal pattern of malaria by Plasmodium species in Batu town health facilities

Season	Month	No. examined	Slide positive n, (%)	*Pf*, n	*Pv*, n	Mixed, n	P- value
Dry season	April	93	14 (15.05%)	7	7	0	0.077
Wet season	May	89	11 (12.36%)	6	4	1	
	June	99	21 (21.21%)	7	14	0	
	July	75	15 (20.27%)	8	6	1	
	Total	356	61 (17.13%)	28	31	2	

Pf: Plasmodium falciparum, Pv: Plasmodium vivax

Among patients treated for malaria at health facilities in Batu town 82% of patients were treated at private health facilities while 18% at government health facilities (Figure 4).

Logistic regression analysis showed that individuals who use ITN were less likely to get malaria infection (OR = 0.38, 95% CI (0.194, 0.743), and P = 0.005). Individuals who had been living closer to stagnant water were almost three-fold times to get malaria infection than those who were found at a distant from reservoir water (OR= 2.97, 95% CI (1.68, 5.26) and P < 0.001). Similarly, individuals whose houses were sprayed with insecticides were approximately 0.2 times less chance of getting infection with malaria as compared to those whose houses were not sprayed with insecticides (OR = 0.18, 95% CI (0.097,0.34) and P < 0.001) (Table 5).

Table 5. Logistic regression analysis for association of other risk factors with malaria infections in the study area, from April – July, 2018.

Variables	Category	Malaria cases (n = 61)	Malaria negatives (n = 295)	OR (CI at 95%)	P- value
Sex	Male	32	184	0.67 (0.384,1.17)	0.156
	Female	29	111		
ITN utilization	Yes	16	38	0.38, (0.194,0.743)	0.005
	No	45	257		
Presence of stagnant water	Yes	38	106	2.97, (1.68, 5.26)	<0.001
	No	23	189		
Insecticide spray	Yes	26	39	0.18, (0.097,0.34)	<0.001
	No	35	256		

OR: odds ratio, CI: confidence interval

Discussion

The finding of the current four months (April – July, 2018) study revealed that malaria infection in the study participants was 61(17.13%). This prevalence is larger than that reported from other parts of Ethiopia such as 0.93% from Butajira [25] and 7% from Arba Minch hospital [5]. However, the current result is less than that of patients attending Wonago health centers, 28.1% [21], Hadiya, 25.8% [26] and Hallaba, 82.8% [9]. The observed differences might be due to altitudinal, seasonal and other climatological variations that contribute for *Anopheles* mosquito breeding and malaria control measures implemented in the study areas. The lower prevalence of malaria at Buta Jira [25] and Arba Minch [5]compared to Batu town might be Buta Jira is found at higher altitude and at Arba Minch the study was conducted almost during dry season when very low malaria prevalence is expected in the country. On the other hand higher malaria prevalence was recorded at Wonago health center because the study was conducted during major malaria transmission season. However, the reason why higher prevalence was

recorded at Hadiya [26] and Halaba [9], almost irrespective of season (similar to Batu town) and altitude (higher than Batu town) might be due to climatic and vector factors that might favour more malaria transmission compared to Batu town. But this needs further investigation.

With respect to Plasmodium species prevalence, *P. vivax* accounted for the highest cases. This finding is in agreement with the study conducted at Halaba health center, with 70.41% for *P. vivax,* 23.08% for *P. falciparum* and the remaining, 6.51% mixed infection [9]. It is also similar with the study conducted at Aleta Wondo that revealed 66% of *P. vivax* and 34% of *P. falciparum* infection [27]. The result of the study conducted in Dilla town [6] at health centers also showed *P. vivax* accounting for 62.5%, followed by *P. falciparum* for 26.8% and mixed infection with both *P. vivax* and *P. falciparum* for 10.7% agreeing with the present finding. From the surrounding area of Dilla town 85% prevalence of *P.vivax* was also reported [28]. The higher prevalence of *P. vivax* over *P. falciparum* might be attributed to the relapsing dormant liver stage and CQ resistance nature of the *P. vivax*. Study conducted by Ketema et al. [29] on the therapeutic efficacy of CQ treatment for *P. vivax* showed a two-fold increase in the prevalence of CQ resistant *P. vivax* in South Ethiopia.

In the present study, relatively males were more infected with malaria than their female counterparts, but did not show statistically significant association which is in agreement with the result of retrospective of study of Batu town health facilities [11]. It is also in agreement with the findings of Regasa [9] at Arba Minch hospital, Alemu et al. [17] from Jimma town who reported higher infection rates of malaria among males than females. The higher prevalence of malaria among males might be males engage in outdoor activities and recreation during the nights outside home which make them more prone to *Anopheles* mosquitoes breeding sites. Study conducted by Kenea et al. [30] at Adami-Tulu Jido Kombolcha (close to our study area) showed that greater proportion (76.6%) of human biting activities of *Anopheles* mosquitoes occurs outdoors than indoors during early part of the night. Peak biting times for *An. arabiensis* (the major vector in the area) [19] that begins early nights [31] coincide with life activities of male individuals. Similar study conducted at Bioko Island, Equatorial Guinea, showed high level of outdoor biting of *An. gambiae* (s.s) occurred throughout the night [32].

Malaria infection also occurred among all age groups. However, the highest malaria infection occurred in age groups older than fourteen having statistically significant difference. This result is in agreement with the findings of Regessa [9], Molla and Ayele [6]. The highest prevalence of malaria in this age group might be attributed to their stay out of home during biting time of *Anopheles* mosquitoes.

In the current study area, during the four months, though there was no statistically significant difference, more malaria cases were detected during June and July than in April and May. This might be because during April and May it was dry season but rain occurred during June and July which might create conducive breeding ground for *Anopheles* mosquitoes. Generally, seasonal variation in malaria transmission is a well established feature of unstable malaria where in Ethiopia [33] 2.6% in dry season (April/May) and 5.8% during wet season (September-November) was reported.

In the context of malaria elimination, involving private health sector is essential for completely and timely reporting of malaria cases [34]. Investigation of the role of private health facilities in the town in diagnosing and treating malaria infected patients showed that more number of patients was attending these facilities. Survey study conducted by Jerene and et al. [35] showed that 86% private health facilities in Oromia regional state of Ethiopia were providing malaria diagnosing and treatment services. At private health facilities because of fear of profit oriented and burden of drug pressure which cause anti-malarial drug resistance, the town health office and regional health bureau forces them to treat malaria cases only once confirmed by microscopic examination, but the offices allows public health facilities to treat malaria cases confirmed by microsope and presumptively as well. Because of this reason more parasitologically confirmed cases were treated at private health facilities. On the other hand, preference of some patients to be treated at private health sectors than government health facilities might be another reason.

In the present study living in the nearby stagnant water was identified as a risk factor for malaria infection. Among those infected with malaria, more cases occurred in patients who live nearby stagnant water. This is in line with study conducted in Dilla town and its surroundings by Molla and Ayele [6]. This can be explained by the fact that stagnant water serves as a suitable breeding ground for *Anopheles* mosquitoes. Those individuals whose houses were not sprayed with insecticide get more likely malaria infection than those whose houses were sprayed. Individuals having and using insecticide treated nets were less likely to get malaria infection than those not having bed nets which is in agreement the findings of Molla and Ayele [6] and Belete and Roro [22].

The present study is not without limitations. Firstly, the study was conducted during the low malaria transmission season (only within four months) before major transmission season (September to December), therefore, the actual picture of malaria prevalence could not be addressed. Secondly, the study is facility based which involved only symptomatic patients who visited health facilities to seek treatments for some disease conditions. Asymptomatic malaria carriers from the community of the town who do not visit health facilities and seek treatments were not involved due to lack of logistics and financial constraints. Thirdly, malaria diagnosis was conducted using only with gold standard, microscopic examination. Robust molecular diagnostic techniques such as polymerase chain reaction, loop-mediated isothermal amplifications which could detect low density infections especially during low transmission season were not employed due to lack of budget, logistics and molecular laboratory set-up. If these techniques were used it would have been possible to detect malaria cases from some of the patients whose samples were reported negative by microscopic examination.

Conclusion

From the result of the present study it can be concluded that both *P. falciparum* and *P. vivax* were the dominant species in the Batu town. However, the prevalence of *P. vivax* is slightly higher than that of *P. falciparum*. In the current study malaria detection from febrile patients attending health facilities was conducted only by using microscopic examination. However, in order to get real burden of malaria in the town, both symptomatic and asymptomatic studies should be carried out by microscopic examination

supplemented with molecular techniques such as polymerase chain reaction and loop mediated isothermal amplification. The study also revealed that there is association between malaria and several risk factors. Generally, malaria is still public health problem in Batu town which might be true for other urban areas in the country, therefore appropriate control measures should be scaled-up in the town in order to minimize malaria related morbidity and mortality.

Abbreviations

AL: Arthemether-lumefantrine, CI: Confidence interval, CQ: Chloroquine, FMOH: Federal Ministry of health, ITN: Insecticide treated net, OR: Odds ratio, SPSS: Statistical package for social science, SSA: Sub-Saharan Africa, WHO: World health organization

Declarations

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Author contributions

JH and HD conceived and design the study. JH was responsible for collecting and statistically analyzing the data. HD was responsible for the supervision of the work. JH wrote the first draft of the manuscript. HD reviewed the manuscript. Both authors read and approved the final manuscript.

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Availability of data and materials

The authors confirm that all data underlying the findings are fully available without restriction. All relevant data are within the manuscript.

Ethics approval and consent to participate

The study protocol was reviewed and approved by the research and ethical committee of Adama Science and Technology University. Permission letter from the Adama City health office was maintained.

Consent for Publication

Applicable.

Competing interests

The authors declare that they have no competing interests.

References

1. WHO. World Malaria Report 2017, Geneva: World Health Organization; 2017.
2. WHO. World Malaria Report 2014, Geneva;World Health Organization;2014.
3. FMOH. Federal Ministry of Health. National Strategic Plan for Malaria Prevention, Control and Elimination in Ethiopia 2010–2015. Addis Ababa: Federal Ministry of Health; 2010.
4. Carter Centre. Summary proceedings 4th annual malaria control program review. Ethiopia and Nigeria. Georgia: p.30. Carter Center; 2013.
5. Regasa B. Magnitude of malaria infection in Ethiopia. Glob J. Medi Res. 2014; 14:19-21.
6. Molla E, Ayele B. Prevalence of malaria and associated factors in Dilla town and the surrounding rural areas, Gedeo Zone, Southern Ethiopia. J Bacteriol Parasitol. 2015; 6:5.
7. FMOH. Federal Ministry of Health of Ethiopia. Malaria Diagnosis and Treatment Guidelines for Health Workers. Addis Ababa: Federal Ministry of Health; 2004.
8. Gebretsadik D, Feleke D, Fiseha M. Eight-year trend analysis of malaria prevalence in Kombolcha, South Wollo, North-central Ethiopia: a retrospective study. Parasit Vectors. 2018; 11:55.
9. Tefera G. Prevalence of malaria and associated factors among patients attending at Hallaba Health Center, Southern Ethiopia. Immun Infect Dis. 2014; 2(3): 25- 29.
10. File T, Dinka H, Golassa L. A retrospective analysis on the transmission of Plasmodium falciparum and Plasmodium vivax : the case of Adama City , East Shoa Zone. Malar J. 2019;18:193.
11. Hassen J, Dinka H. Retrospective analysis of urban malaria cases due to Plasmodium falciparum and Plasmodium vivax: the case of Batu town, Oromia, Ethiopia. 2020; Heliyon, 6 e03616.
12. Taye A, Hadis M, Adugna N, Tilahun D,Wirtz RA. Biting behavior and *Plasmodium* infection rates of *Anopheles arabiensis* from Sille, Ethiopia. Act Trop. 2006; 97: 50–54.
13. Massebo F, Balkew M, Gebre-Michael T, Lindtjorn B. Blood meal origins and insecticide susceptibility of Anopheles arabiensis from Chano in South-West Ethiopia. Parasit Vectors. 2013; 6:44.
14. Carter TE, Yared S, Gebresilassie A, Bonnell V, Damodaran L, Lopez K, et al. First detection of *Anopheles stephensi Liston* , 1901 (Diptera : culicidae) in Ethiopia using molecular and morphological approaches. Act Trop. 2018;188: 180–186.
15. Wilson ML, Krogstad DJ, Arinaitwe E, Areyalo-Herrera M, Chery L, Ferreira MU, et al. Urban Malaria: Understanding its epidemiology, ecology and transmission across seven diverse ICEMR National Sites. Am J Trop Med Hyg. 2015; 93:110-123.
16. Mathanga Don P, Tembo AK, Mzilahowa Th, Bauleni A, Mtimaukenena K, Taylor TE, et al. Patterns and determinants of malaria risk in urban and periurban areas of Blantyre, Malawi. Malar J. 2016; 15 (1): 590.

17. Alemu A, Tsegaye W, Golassa L, Abebe G. Urban malaria and associated risk factors in Jimma town, south-west Ethiopia. Malar J. 2011; 10:173.
18. FMOH. Federal Ministry of Health. National Malaria Elimination Roadmap. Addis Ababa: Federal Ministry of Health; 2016.
19. Abose T, Ye-ebiyo Y, Olana D, Alamirew D, Beyene Y, Regassa L, et al. Reorientation and definition of the role of malaria vector control in Ethiopia; the epidemiology and control of malaria with special emphasis to the distribution, behavior and susceptibility to insecticides of anopheline vectors and chloroquine resistance in Ziway, Central Ethiopia and other areas. Addis Ababa: MOVBD, MOH Ethiopia, 1998.
20. Kenea O, Balkew M, Gebre-Michael T. Environmental factors associated with larval habitats of anopheline mosquitoes (Diptera: Culicidae) in irrigated and major drainage areas in the middle course of the Rift Valley, central Ethiopia. J Vec B Dis. 2011; 48:85–92.
21. Daniel WW, Cross ChL. Determination of sample size: A Foundation of Analysis in the Health Sciences. Biostatistics, 10th edition, P. 190-92, John Wiley & Sons, Inc., Hoboken, 2013.
22. Belete EM, Roro AB. Malaria prevalence and associated risk factors among patients attending Chichu and Wonago Health Centers, South Ethiopia. J Res Health Sci. 2016;16(4):185-189.
23. WHO. Malaria Microscopy Quality Assurance. Geneva: World Health Organization, 2009.
24. FMOH. Federal Ministry of Health. National malaria guidelines. 3rd ed. Addis Ababa; Federal Ministry of Health; 2012.
25. Woyessa A, Deressa W, Ali A, Lindtjorn B. Prevalence of malaria infection in Butajira area, South-central Ethiopia. Malar J. 2012; 11:84.
26. Delil RK, Dileba TK, Habtu YA, Gone TF, Leta TJ. Magnitude of malaria and factors among febrile cases in low transmission areas of Hadiya Zone, Ethiopia: A facility based cross sectional study. PLoS One. 2016; 11(5):e0154277.
27. Milikit D, Worede A, Molargi T, Aboye G, Gebrehiwot T. Prevalence of malaria among patients attending in Aleta Wondo Health Center, Southern Ethiopia. 2007; pp.13-26.
28. Gari T, Kenea O, Loha E, Deressa W, Hailu A, Balkew M, et al. Malaria incidence and entomological findings in an area targeted for a cluster randomized controlled trial to prevent malaria in Ethiopia: results from a pilot study. Malar J. 2016; 15:145.
29. Ketema T, Getahun K, Bacha K. Therapeutic efficacy of chloroquine for treatment of *P. vivax* malaria cases in Halaba district, South Ethiopia. Parasit Vectors. 2011;4:46.
30. Kenea O, Balkew M, Habte T, Gebre-Michael T, Deressa W, Loha E. et al. Human-biting activities of *Anopheles* species in south-central Ethiopia, Parasit Vectors. 2016; 9:527.
31. FMOH. Federal Ministry of Health. An Epidemiological Profile of Malaria in Ethiopia. Addis Ababa: Federal Ministry of Health, 2014.
32. Overgaard HJ, Saebo S, Reddy MR, Reddy VP, Abaga S, Matias A, et al. Light traps fail to estimate reliable malaria mosquito biting rates on Bioko Island, Equatorial Guinea. Malar J. 2012; 11:56

33. Yewhalaw D, Kassahun W, Woldemichael K, Tushune K, Sudaker M, Kaba D, et al. The influence of the Gilgel-Gibe hydroelectric dam in Ethiopia on caregivers' knowledge, perceptions and health-seeking behavior towards childhood malaria. Malar J. 2010; 9:47.
34. WHO. Global Malaria Programme. World malaria report 2015, Geneva: World Health Organization, 2015.
35. Jerene D, Fentie G, Teka M, Girma S, Chibsa S, Teka H, et al. The role of private health facilities in the provision of malaria case management and prevention services in four zones of Oromia Regional State, Ethiopia. Int Health. 2012; 4:70–3.

Figures

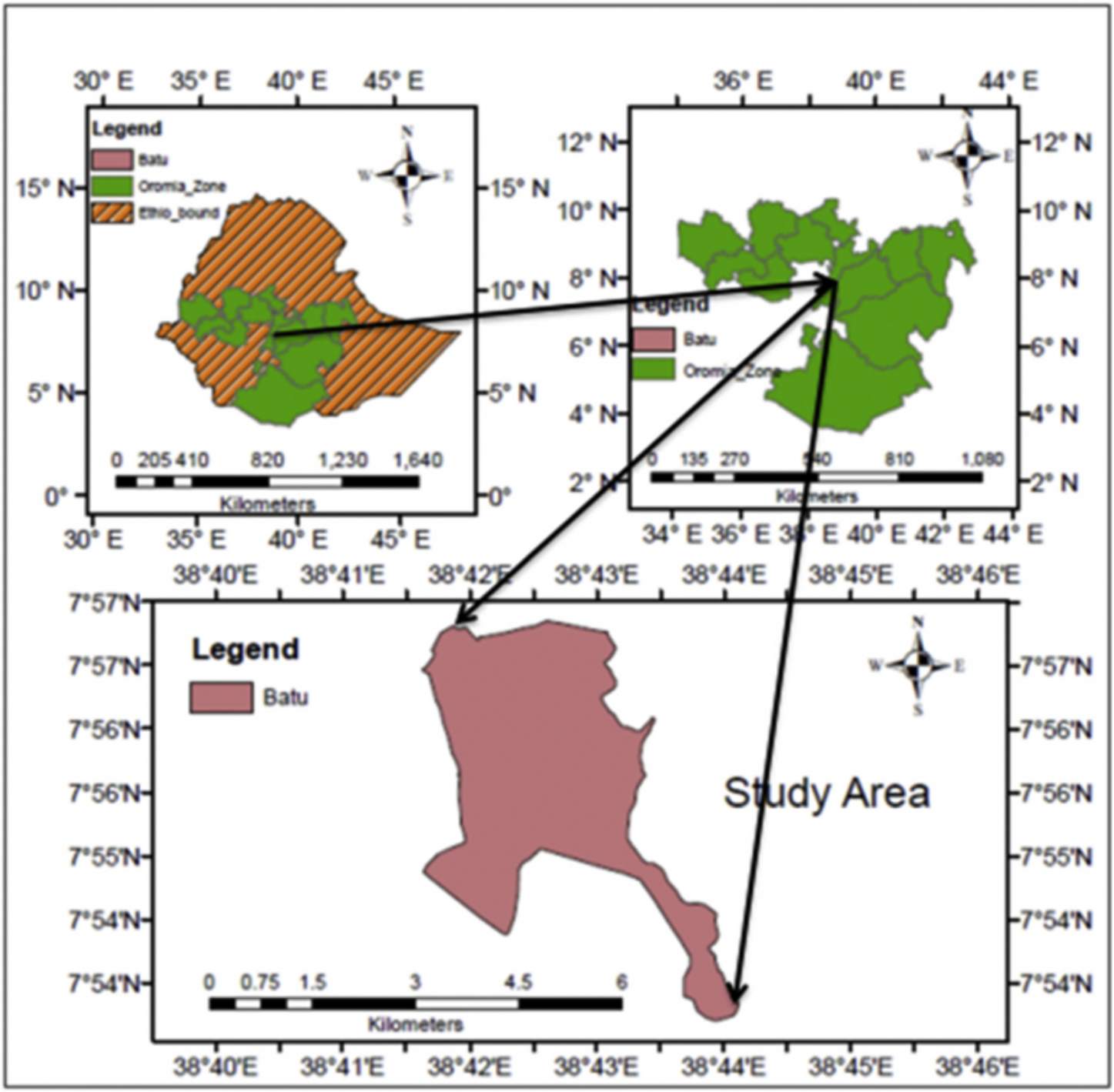

Figure 1

Map of the Batu/Zeway town

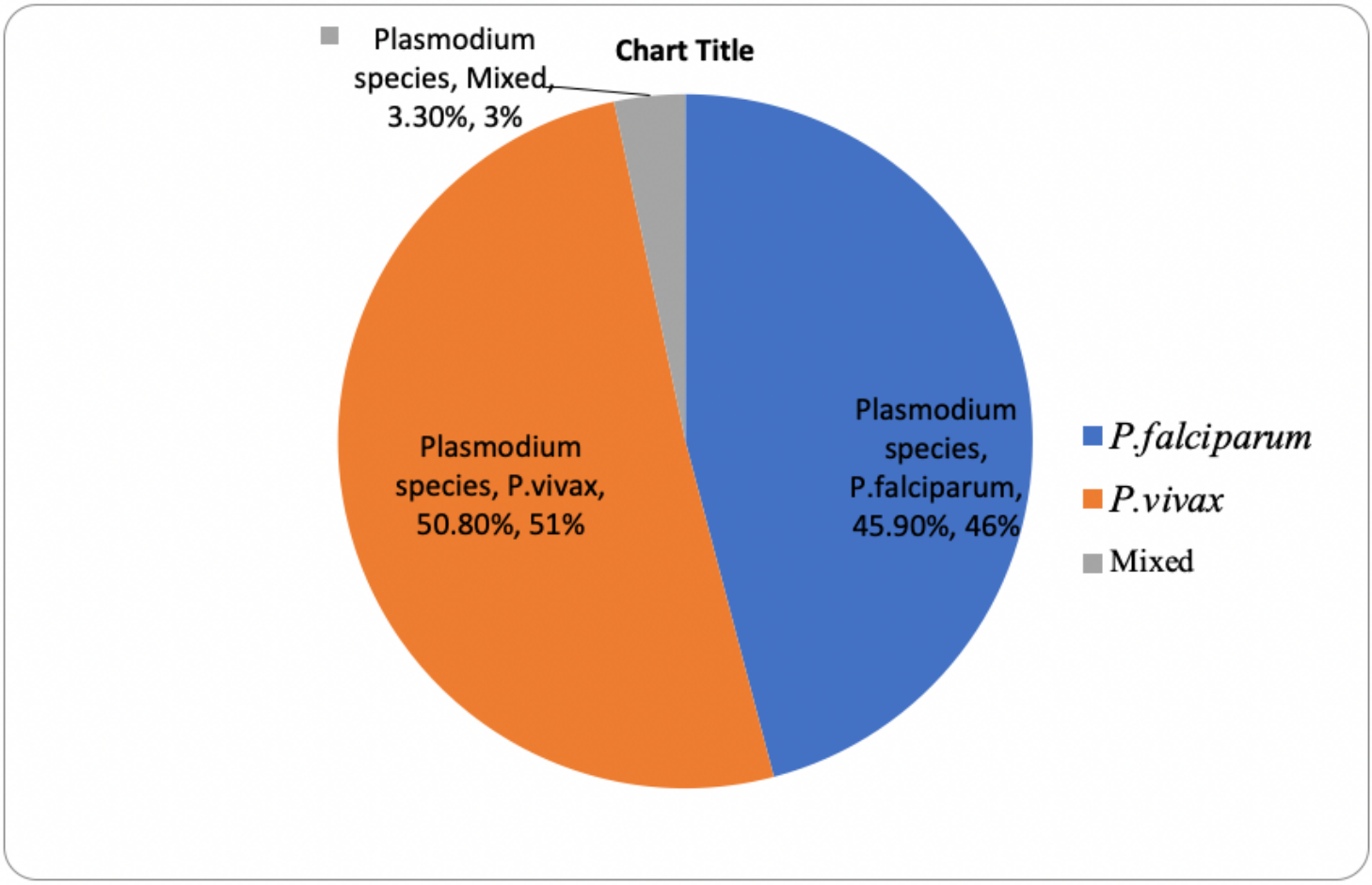

Figure 2

Percentages of Plasmodium species at Batu town from April to July, 2018

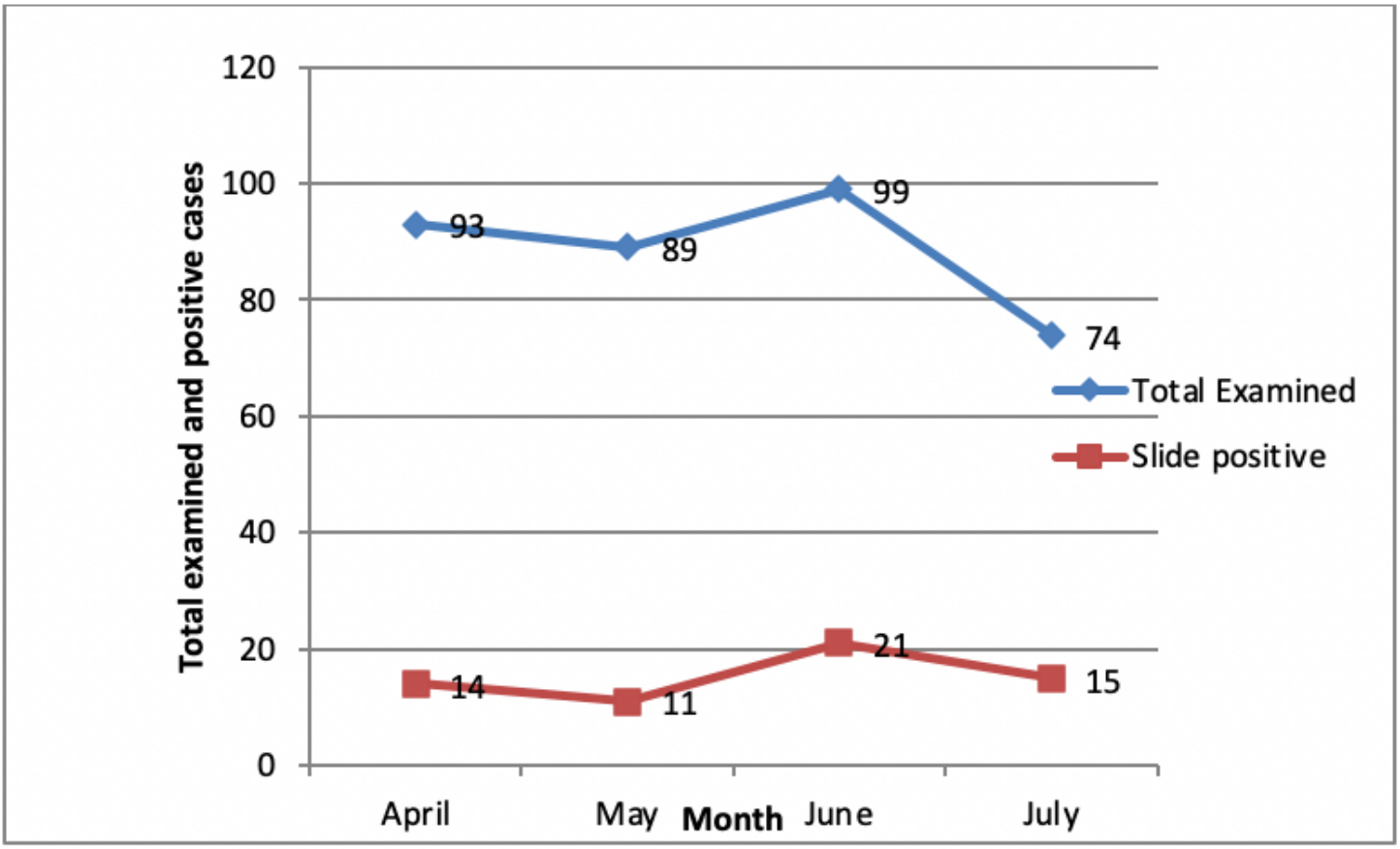

Figure 3

Monthly profile of malaria cases at Batu town health facilities, from April – July, 2018.

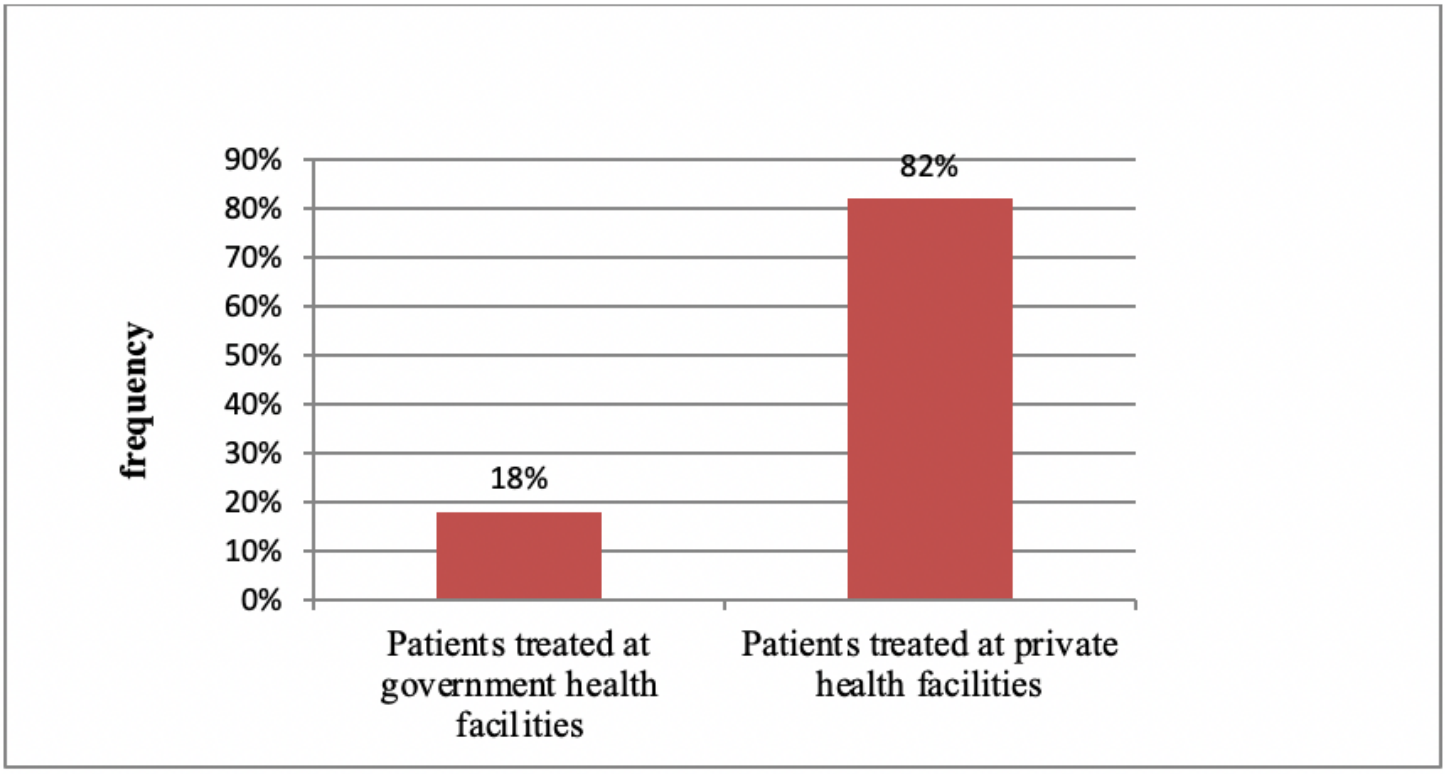

Figure 4

Comparison of patients treated for malaria at government and private health facilities.