Assessment of malaria prevalence in Boset District, East Shawa Zone, Oromia Regional State, Ethiopia: a retrospective study

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Abstract
Objective: In this study, we aimed to assess the epidemiological profile and associated risk factors of malaria in Boset District using clinical records from the Boset District Health Office Central Surveillance Unit, East Shawa Zone, Oromia, Ethiopia.

Methods: This health facility-based retrospective cross-sectional study included clinical malaria data for 5 years (2016–2020) recorded at all public and private health facilities in the district.

Results: The present study revealed an overall malaria slide positivity rate of 12.4% (21,059/169,986), ranging from 23.3% to 5.3% during 2016–2020 in Boset District. Malaria cases were recorded in all age groups, but individuals aged 15 years and above accounted for a higher (56.2%) average proportion of malaria cases. Concerning the relative proportion of malaria parasite species, Plasmodium falciparum was slightly predominant (58%) over P. vivax (42%).

Conclusion: The present study revealed a declining trend in malaria cases over the 5-year study period in Boset District. Scaling up the available malaria prevention strategies and control measures is recommended to achieve malaria pre-elimination.

Keywords
Boset District, malaria, Plasmodium falciparum, Plasmodium vivax, transmission, Ethiopia

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Introduction
Malaria is a life-threatening infectious disease caused by the protozoan parasite Plasmodium. Despite the significant reduction in malaria cases achieved by 2020, over 241 million cases of malaria and 627,000

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malaria-attributable deaths occurred worldwide in the same year, among which 95% of cases and 96% of deaths occurred in Africa. Although there has been a considerable decline in malaria incidence since the year 2000, the disease remains a public health threat in areas where malaria is endemic, especially in Sub-Saharan African countries, which experienced an expansion of malaria in 2019 in comparison with 1990.

*Plasmodium falciparum* and *Plasmodium vivax* are among the five *Plasmodium* species known to infect humans, with a high prevalence and wide distribution in Ethiopia. It has been reported that 60% and 40% of all reported malaria cases are caused by *P. falciparum* and *P. vivax*, respectively. Studies have found that malaria is among the 10 leading causes of morbidity and mortality in children under age 5 years in Ethiopia. Malaria transmission is very heterogeneous, seasonal, and unstable across Ethiopia, and transmission intensity varies according to landscape and climate. Transmission peaks bi-annually from September to December and from April to May, coinciding with the main harvest seasons. Studies have reported that certain variables are strongly associated with the transmission of malaria elsewhere in the world. Human-induced risk factors, such as water resource developments and the presence of dams, have been reported to intensify malaria transmission in lowland and midland ecological settings of Ethiopia. Accordingly, studies have revealed that the mean monthly malaria incidence is generally higher in villages near dams than in those further from a dam. Similarly, studies in the Tigray Region of northern Ethiopia report that the overall incidence of malaria in villages close to a dam is higher than that in communities far from a dam.

Recent studies report that Ethiopia has achieved the target 50% reduction in malaria incidence, which is among the Millennium Development Goals. The country is on track for a further 40% reduction in malaria incidence (along with Rwanda, Zambia, and Zimbabwe) and malaria mortality rates (together with Zambia) by 2020. Despite the substantial reduction in malaria morbidity and mortality in Ethiopia since 2001, the case incidence remains high, and malaria remains the main cause of morbidity in the country, with 3,331,599 confirmed cases and 59,370 hospital admissions in 2012 to 2013. Although its prevalence is relatively low compared with other African nations, the disease remains the leading cause of outpatient morbidity and is among the leading causes of inpatient morbidity. Recent studies have shown that malaria results in considerable adverse effects on the health and socioeconomic development of Ethiopia. Despite the country’s commitment to its control program, malaria remains a huge challenge to the public health and economic sectors. The prevailing, conducive weather conditions coupled with tremendous socioenvironmental changes are believed to contribute to the surge in malaria throughout most areas of the country. Most importantly, irrigation schemes and water harvesting projects in malaria-endemic areas of Ethiopia represent serious challenges not only in terms of the establishment of year-round transmission but also for the occurrence of sudden outbreaks of disease.

Most areas in the East Shawa Zone, including Boset District, are among major centers with year-round irrigation farming of vegetables and fruits. Surface irrigation creates an environment conducive to mosquito breeding and proliferation, leading to stable transmission of malaria infection throughout the year. Despite the favorable weather conditions and presence of irrigation farming, both risk factors for stable malaria transmission, there are limited reports with regard to the malaria
prevalence and associated risk factors in Boset District, East Shawa Zone. Therefore, in this study, we aimed to assess trends in the malaria prevalence in Boset District.

**Methods**

**Description of the study area**

This study was carried out in Boset District, East Shawa Zone, Oromia Regional State, Ethiopia. Olanchiti is the main town in the district, with latitude and longitude 8°40′N 39°26′E and an elevation of 1436 meters above sea level. Olanchiti is located 25 km from Adama Town, in the middle of the Great Ethiopian Rift Valley, along the road from Addis Ababa to Dire Dawa (Figure 1). According to population projection data of the Central Statistical Agency, the total population of Boset District was estimated to be 189,795, with a 22.5% and 77.5% urban and rural population, respectively, in the year 2017. The district receives between 621 mm and 1012.7 mm of annual rainfall and has an annual temperature of 14.3°C to 31.8°C, with heavy rains during the months of June to September and short rains in April and May. Boset District is a malarious area in this region. Malaria is a leading cause of morbidity and mortality, being among the 10 leading diseases reported in local health facilities. According to the Health Office of the district, there are currently 33 public health posts, 7 health centers, and 1 primary hospital (Olanchiti Hospital) in this area. The outpatient department of the hospital provides six main types of services: those for children under age 5 years and age 5 to 14 years (one program for each age group), services for patients aged ≥15 years, emergency services, and chronic disease evaluation and treatment. Inpatient

![Figure 1. Map of study area, Boset District and Olanchiti Town (developed using Arc-GIS Desktop version 10.3.1; Esri, Redlands, CA, USA).](image-url)
department services include pediatrics, gynecology and maternity, internal medicine, and surgery. In addition to public health facilities, there are eight private health posts and clinics.

**Study design and data collection**

We conducted a retrospective study to analyze the malaria trends in Boset District, East Shawa Zone, using malaria data over 5 years (2016–2020) recorded in the surveillance database of the district. The data source was malaria cases confirmed microscopically and/or via rapid diagnostic test (RDT) in public and private health facilities as per the national guidelines for parasitological diagnosis of malaria. The extracted data were part of a report compiled by the zonal Health Office Central Surveillance Unit via district health offices, organized and managed using a health management information system. The present study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations for reporting observational studies.17

**Ethical approval**

The data for this research were accessed after ethical approval was received from the Adama Science and Technology University (Certificate Ref. No. RECS0 ANS/BIO/04/2020. September 2020). Informed consent was not needed as there was no direct interaction with study participants. Only the data of treatment seekers was accessed.

**Data analysis**

Data collection was followed by proper data organization, analysis, and interpretation. Retrospective data were qualitatively and quantitatively analyzed to check the frequency and strength of the associations among variables using IBM SPSS version 20 (IBM Corp., Armonk, NY, USA). Results were considered statistically significant with \( p < 0.05 \).

**Results**

Among an overall 169,986 examined slides and/or RDTs, 21,059 (12.4%) malaria-positive cases were recorded during 2016 to 2020 in all public and private health facilities of Boset District. Among positive cases, 12,025 (57.1%) and 9034 (42.9%) were among male and female individuals, respectively. The data for mixed infection were incomplete and inconsistent between public and private health facilities; therefore, these data were excluded. The malaria trend in the district over the 5-year study period revealed a sharp decline in the slide positivity rate (SPR) from 23.3% (9728/41,815) in 2016 to 5.3% (1657/30,989) in 2020 (Figures 2 and 3).

As shown in Table 1, a higher SPR (14.0%) was observed in public facilities than in private health facilities (13.9%) and Olanchiti Hospital (7.5%).

As shown in Figure 4, the malaria SPR by sex and age showed a considerable decrease over the 5-year period. With regard to age profile, the SPR was significantly higher for the age group \( \geq 15 \) years (56.2%) than for other age groups \((p < 0.01)\), as shown in Figure 5.

As for the relative proportion of malaria parasite species among positive cases in Boset District, \( P. falciparum \) showed a slight predominance (58%) over \( P. vivax \) (42%) \((p < 0.04)\), with an SPR of 7.2% and 5.2%, respectively. Both species showed a declining trend in the SPR during 2016–2020 (Figure 6).

**Discussion**

The current study revealed that the overall malaria SPR in Boset District was 12.4% (21,059/169,986), implying a relatively
average malaria morbidity in this area. The positivity rate from public health facilities in the district was higher than the SPR in Olanchiti Hospital and in private health facilities (Table 1). This is perhaps owing to ease of accessibility of public health facilities for most treatment seekers. The present study showed a lower malaria SPR compared with previous studies in Hadiya Zone, Ethiopia among febrile cases with
an overall SPR of 25.8%,\textsuperscript{18} and in Batu Town with an SPR of 17.13%.\textsuperscript{19} Despite the numerous studies conducted in Ethiopia at national and regional levels on expanding malaria interventions, malaria remains a leading communicable disease, causing considerable morbidity. There was a clear decline in the malaria incidence rate and malaria death rate in Ethiopia from 2001 to 2016; however, the malaria case number and incidence remained high, with 19.8 cases per 1000 people reported in 2016, exceeding the World Health Organization standard for pre-elimination.

Regarding the trend in malaria cases across the study period, a sharp decline from 23.3% to 5.3% during 2016 to 2020 was observed (Figure 2). Despite well-documented seasonal variation in the malaria prevalence and incidence in Ethiopia,\textsuperscript{20–24} meteorological variables (mainly rainfall) are strongly associated with the incidence of both \textit{P. falciparum} and \textit{P. vivax} malaria,\textsuperscript{25} according to data records used in the present study (Supplementary Figure 1).

Regarding the types of \textit{Plasmodium} species associated with infection, \textit{P. falciparum}

### Table 1. Distribution of malaria cases in Boset District, Central Ethiopia, 2016 to 2020.

| Year | Total no. of slides examined | P. falciparum | P. vivax | Total no. of slides/RDTs examined | P. falciparum | P. vivax | Total no. of slides/RDTs examined | P. falciparum | P. vivax |
|------|-----------------------------|--------------|----------|----------------------------------|--------------|---------|----------------------------------|--------------|---------|
| 2016 | 7928                        | 438          | 301      | 24,978                           | 3423         | 2757    | 8909                             | 1596         | 1213    |
| 2017 | 7802                        | 253          | 334      | 18,048                           | 1427         | 868     | 8788                             | 827          | 659     |
| 2018 | 7077                        | 330          | 283      | 15,321                           | 1147         | 654     | 9420                             | 772          | 405     |
| 2019 | 8503                        | 285          | 224      | 14,154                           | 603          | 375     | 7926                             | 143          | 85      |
| 2020 | 9844                        | 295          | 328      | 13,857                           | 559          | 291     | 7431                             | 125          | 59      |
| Total| 41,154                      | 1601         | 1470     | 86,358                           | 7159         | 4945    | 42,474                           | 3463         | 2421    |

*Public health facilities refers to all public health centers and public health posts. \textit{P.}, \textit{Plasmodium}; RDT, rapid diagnostic test.

![Figure 4. Percentage distribution of malaria-positive cases by sex and age in Boset District, Central Ethiopia, 2016 to 2020.](image-url)
showed a slight predominance (58%) over \( P. \) \textit{vivax} (42%) among malaria-positive cases. This finding is in line with the previously reported \textit{Plasmodium} composition in Ethiopia, where \( P. \) \textit{falciparum} and \( P. \) \textit{vivax} account for 60% and 40% of \textit{Plasmodium} species in this country, respectively. The present study findings are also in agreement with previous reports in Ethiopia in which \( P. \) \textit{falciparum} and \( P. \) \textit{vivax} account for

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure5.png}
\caption{Distribution of malaria slide positivity rate (SPR) by age in Boset District, Central Ethiopia, 2016 to 2020.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure6.png}
\caption{Five-year trend of malaria cases in Boset District, Central Ethiopia, 2016 to 2020.}
\end{figure}
71.8% and 23.9% in Wolaita Zone and 75.2% and 24.5% in Benishangul-Gumuz Regional State, respectively.26,27 However, our findings are in contrast to reports that \textit{P. vivax} is the predominant species in Jimma Town, Hadiya Zone, the highland fringes of Butajira, Adama Town, and Batu Town, Ethiopia, with proportions of 71.4%, 86.5%, 71.7%, 61%, and 50.5%, respectively.18,19,23,28,29 Despite differences in proportions, nearly all studies concur in reporting that \textit{P. vivax} is co-endemic with \textit{P. falciparum} in Ethiopia, one of the few African countries in which this situation exists. Despite earlier studies showing that \textit{P. falciparum} and \textit{P. vivax} account for 60% and 40% of all malaria cases, respectively,3 recent studies report that these two species have equal case incidence rates,30 although some studies report that \textit{P. vivax} is the main causative agent of malaria in Oromia Regional State in Ethiopia.31,32

In the present retrospective data analysis, more malaria cases were recorded among male individuals than their female counterparts. This result is in line with previous local studies.33,34 This might be associated with the traditional work culture in Ethiopia where male individuals are more engaged in outdoor activities like agriculture than female Ethiopians. The age distributions showed that individuals aged 15 years and above accounted for a higher proportion of malaria cases. This finding is in agreement with previous studies elsewhere in the country,21,23,27,35 this age group also accounts for the most hospital admissions among all age groups.

There are several study limitations that should be noted. Data for mixed infections were excluded because of incomplete and inconsistent reports between public and private health facilities. Inclusion of these data could have enriched the study results. In addition, limitations associated with the recording and handling of data might affect the reliability of the findings.

Conclusion
In the present study, we found a malaria SPR of 12.4% among public and private health facilities in Boset District from 2016 to 2020, with a sharp decline from 23.3% in 2016 to 5.3% in 2020. Regarding the distribution of \textit{Plasmodium} species among malaria-positive cases, \textit{P. falciparum} (58%) was more prevalent than \textit{P. vivax} (42%). The declining trend in malaria cases over the 5-year study period may reflect the results of expanded malaria interventions at national and regional levels in Ethiopia. To maintain this reduction in malaria cases across the area and for eventual elimination of the disease, scaling up the available malaria prevention strategies and control measures is necessary.

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Author contributions
BC designed the study, collected and analyzed the data, and wrote the paper. TT designed the study, collected the data, and reviewed the paper. Both authors read and approved the manuscript.

Data availability statement
The authors confirm that all data underlying the findings are fully available without restriction.

Declaration of conflicting interests
The authors declare that there is no conflict of interest.

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References
1. World Health Organization. World malaria report 2021; 2021. Geneva, Switzerland. https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2021. Accessed 27 May 2022.
2. Liu Q, Jing W, Kang L, et al. Trends of the global, regional and national incidence of malaria in 204 countries from 1990 to 2019 and implications for malaria prevention. J Travel Med 2021; 28: taab046. https://doi.org/10.1093/jtm/taab046
3. Deressa W, Ali A and Enqusellassie F. Self-treatment of malaria in rural communities, Butajira, southern Ethiopia. Bull World Health Organ 2003; 81: 261–268.
4. Deribew A, Tessema GA, Deribe K, et al. Trends, causes, and risk factors of mortality among children under 5 in Ethiopia, 1990–2013: findings from the Global Burden of Disease Study 2013. Popul Health Metr 2016; 14: 42.
5. Federal Ministry of Health. National malaria guidelines. 3rd ed. Addis Ababa, 2012.
6. Degefa T, Zeynudin A, Godesso A, et al. Malaria incidence and assessment of entomological indices among resettled communities in Ethiopia: a longitudinal study. Malar J 2015; 14: 24.
7. Delenasaw Y, Worku L, Wim VB, et al. Malaria and water resource development: the case of Gilgel-Gibe hydroelectric dam in Ethiopia. Malar J 2009; 8: 21.
8. Kibret S, Wilson GG, Ryder D, et al. Malaria impact of large dams at different eco-epidemiological settings in Ethiopia. Trop Med Health 2017; 45: 4.
9. Ghebreyesus TA, Haile M, Witten KH, et al. Incidence of malaria among children living near dams in northern Ethiopia: community based incidence survey. BMJ 1999; 319: 663–666.
10. Deribew A, Dejene T, Kebede B, et al. Incidence, prevalence and mortality rates of malaria in Ethiopia from 1990 to 2015: analysis of the global burden of diseases 2015. Malar J 2017; 16: 271. https://doi.org/10.1186/s12936-017-1919-4
11. World Health Organization. World malaria report 2019; 2019. Geneva, Switzerland. http://www.who.int/iris/handle/10665/252038. Accessed 17 June 2020.
12. Taffese HS, Hemming-Schroeder E, Koepfli C, et al. Malaria epidemiology and interventions in Ethiopia from 2001 to 2016. Infect Dis Poverty 2018; 7: 103. https://doi.org/10.1186/s40249-018-0487-3
13. Federal Ministry of Health. National Malaria Program Monitoring and Evaluation Plan 2014–2020, Addis Ababa, 2014.
14. Girum T, Shumbej T and Misgun S. Burden of malaria in Ethiopia, 2000–2016: findings from the Global Health Estimates 2016. Trop Dis Travel Med Vaccines 2019; 5: 11.
15. Tadesse F, Fogarty AW and Deressa W. Prevalence and associated risk factors of malaria among adults in East Shewa Zone of Oromia Regional State, Ethiopia: a cross-sectional study. BMC Public Health 2018; 18: 25. https://doi.org/10.1186/s12889-017-4577-0.
16. Central Statistical Agency. 2013 Population projection of Ethiopia for all regions at Wereda level from 2014 to 2017. Federal Demographic Republic of Ethiopia, Addis Ababa. http://www.sciepub.com/reference/163220. Accessed 28 October 2021.
17. von Elm E, Altman DG, Egger M, et al. The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. Ann Intern Med 2007; 147: 573–577.
18. Delil RK, Dileba TK, Habtu YA, et al. 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: e0154277. https://doi.org/10.1371/journal.pone.0154277
19. Hassen J and Dinka H. Retrospective analysis of urban malaria cases due to Plasmodium falciparum and Plasmodium vivax: the case of Batu town, Oromia, Ethiopia. Heliyon 2020; 6: e03616.
20. Chala B and Petros B. Malaria in Finchaa Sugar Factory area western Ethiopia: malaria as a public health problem in Finchaa
Sugar Factory using clinical records and parasitological surveys. *J Parasitol Vector Biol* 2011; 3: 52–58.

21. Ergete S, Sorsa S, Loha E, et al. Trend of malaria cases in Hana and Keyafer health centers, South Omo Zone, Southern Ethiopia. *Ethiop J Health Sci* 2018; 28: 277–286. https://doi.org/10.4314/ejhs.v28i3.5.

22. Tesfa H, Bayih AG and Zeleke AJ. A 17-year trend analysis of malaria at Adi Arkay, north Gondar zone, Northwest Ethiopia,” *Malar J* 2018; 17: 155. https://doi.org/10.1186/s12936-018-2310-9

23. File T, Dinka H and Golassa L. A retrospective analysis on the transmission of *Plasmodium falciparum* and *Plasmodium vivax*: the case of Adama city, East Shoa Zone, Oromia, Ethiopia. *Malar J* 2019; 18: 277. https://doi.org/10.1186/s12936-019-2827-6

24. Addisu A, Tegegne Y, Mihiret Y, et al. A 7-year trend of malaria at primary health facilities in northwestern Ethiopia. *J Parasitol Res* 2020; 4204987. https://doi.org/10.1155/2020/4204987

25. Addisu W and Belay B. Climate variability and malaria transmission in Fogera District, Ethiopia: 2003-2011. *Sci J Public Health* 2014; 2: 234–237.

26. Legesse D, Haji Y and Abreha S. Trend analysis of malaria occurrence in Wolaita Zone, Southern Ethiopia: retrospective cross-sectional study. *Malar Res Treat* 2015; 2015: 123682. https://doi.org/10.1155/2015/123682

27. Alkadir S, Gelana T and Gebreslassie A. A five-year trend Analysis of malaria prevalence in Guba District, Benishangul-Gumuz regional state, western Ethiopia. A retrospective study. *Trop Dis Travel Med Vaccine* 2020; 6: 18. https://doi.org/10.1186/s40794-020-00112-4

28. Alemu A, Tsegaye W, Golassa L, et al. Urban malaria and associated risk factors in Jimma town, south-west Ethiopia. *Malar J* 2011; 10: 173. https://doi.org/10.1186/1475-2875-10-173

29. Woyessa A, Deressa W, Ali A, et al. Prevalence of malaria infection in Butajira area, south-central Ethiopia. *Malar J* 2012; 11: 84. https://doi.org/10.1186/1475-2875-11-84

30. Lo E, Hemming-Schroeder E, Yewhalaw D, et al. Transmission dynamics of co-endemic *Plasmodium vivax* and *Plasmodium falciparum* in Ethiopia and prevalence of antimalarial resistant genotypes. *PLoS Negl Trop Dis* 2017; 11: e0005806.

31. Wilson ML, Krogstad DJ, Arinaitwe E, 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.

32. Golassa L and White MT. Population level estimates of the proportion of *Plasmodium vivax* blood-stage infections attributable to relapses among febrile patients attending Adama Malaria Diagnostic Centre, East Shoa Zone, Oromia, Ethiopia. *Malar J* 2017; 16: 301.

33. Sena L, Deressa W and Ali A. Dynamics of *Plasmodium falciparum* and *Plasmodium vivax* in a micro-ecological setting, Southwest Ethiopia: effects of altitude and proximity to a dam. *BMC Infect Dis* 2014; 14: 625.

34. Yimer F, Animut A, Erko B, et al. Post five-year trend, current prevalence and household knowledge, attitude and practice of malaria in Abeshge, south-central Ethiopia. *Malar J* 2015; 14: 230. https://doi.org/10.1186/s12936-015-0749-5

35. Tefera S, Bekele T, Getahun K, et al. The changing malaria trend and control efforts in Oromia Special zone, Amhara Regional State, North-East Ethiopia. *Malar J* 2022; 21: 128. https://doi.org/10.1186/s12936-022-04149-y