Analyzing the six-year malaria prevalence trends at Metehara Health Center, Central Ethiopia (2017/18–2022/23): Unveiling the resurgence and its impact on malaria elimination goals by 2030—A retrospective study

Aynalem Mandefro (anaafman@gmail.com)
Addis Ababa University, Aklilu Lemma Institute of Pathobiology (ALIPB)
Geletta Tadelle
Wollega University, College of Medicine and Health Sciences
Bacha Mekonen
Malaria and NTDs research team, Bacterial, Parasitic, and Zoonotic Diseases Research Directorate, Ethiopian Public Health Institute, Addis Ababa, Ethiopia
Lemu Golassa
Addis Ababa University, Aklilu Lemma Institute of Pathobiology (ALIPB)

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Abstract

Background

Despite Ethiopia's concerted efforts to eliminate malaria by 2030, the disease continues to pose a significant public health and socioeconomic challenge in the country. The year 2021 witnessed 2.78 million malaria cases and 8041 associated deaths, emphasizing the persistent threat. Monitoring the prevalence trend of malaria is crucial for devising effective control and elimination strategies. This study aims to assess the trend of malaria prevalence at the Metehara Health Center in the East Shoa Zone, Ethiopia.

Methods

A retrospective study, spanning from February to September 2023, utilized malaria registration laboratory logbooks at Metehara Health Center to evaluate the prevalence of malaria from 2017/18 to 2022/23. Malaria and related data were collected using a pre-designed data collection sheet. Descriptive statistics were employed for data summarization, presented through graphs and tables.

Results

Out of 59,250 examined blood films, 17.4% confirmed the presence of *Plasmodium* species. Among the confirmed cases, 74.3%, 23.8%, and 1.84% were attributed to *P. falciparum*, *P. vivax*, and mixed infections, respectively. The trend of malaria exhibited a steady decline from 2017/18 to 2021/22, reaching 9.8% prevalence. However, an abrupt increase to 26.5% was observed in 2022/23. Males accounted for a higher proportion (66%) of cases compared to females (34%). The age group 15–24 years experienced the highest malaria incidence at 42%. Notably, malaria cases peaked during autumn (September to November) at 43% and reached the lowest percentage during spring (March to May) at 13%.

Conclusion

Malaria persists as a significant health challenge in and around Metehara, central Ethiopia, predominantly driven by *P. falciparum*. The five-year declining trend was interrupted by a notable upsurge in 2022/23, indicating a resurgence of malaria in the study area. It is imperative to adopt a reversed strategy to sustain the progress achieved by the national malaria control plan.

Background

Despite notable progress in reducing morbidity and mortality, malaria remains a substantial global public health challenge, with 244 million reported cases and 610,000 deaths in 2021. The disease persists as a formidable issue in Africa, where over 95% of global malaria cases and deaths are concentrated [1]. In

Ethiopia, where approximately 60% of the population resides in malaria-prone areas [2, 3], there were 2.78 million reported malaria cases and 8,041 related deaths in 2021 [1]. Beyond the immediate health impacts, malaria continues to exert significant socioeconomic burdens, particularly affecting over 80% of the rural community [4].

Malaria transmission in Ethiopia is generally characterized by low, unstable, and spatially and temporally heterogeneous patterns [5]. The primary transmission season occurs from September to December, following the main rainy season (June-August), with a minor transmission season observed during March-May [6, 7]. The predominant malaria parasites, *P. falciparum* and *P. vivax*, account for approximately 70% and 30% of all reported cases, respectively [3]. In Ethiopia, *Anopheles arabiensis* is the primary malaria vector, supplemented by *Anopheles pharoensis*, *Anopheles nili*, and *Anopheles funestus* [2, 3], while recent reports highlight the presence of the Asian malaria vector *Anopheles stephensi* [8, 9]. Artemether-lumefantrine (AL) is the first-line treatment for uncomplicated *P. falciparum*, while Chloroquine is recommended for uncomplicated malaria caused by *P. vivax* [3].

The World Health Organization has endorsed the Global Technical Strategy (GTS) 2016–2030, advocating for a community-based approach to enhance access to preventive, diagnostic, and therapeutic measures, ultimately aiming for malaria elimination by 2030 [10]. In alignment with this global initiative, Ethiopia has embraced the GTS and formulated a strategic plan for malaria elimination, targeting districts with an annual parasite index of less than 10 by 2025 and complete elimination by 2030 [2–3, 11]. The successful implementation of this strategic plan has yielded notable progress, evidenced by a significant reduction in the nation's malaria morbidity and mortality. Between 2016 and 2019, there was a remarkable 47% decrease in confirmed malaria cases and a 58% decline in related deaths [2].

Despite a decline in malaria morbidity and mortality in the country, challenges persist due to the development of insecticidal resistance by *Anopheles arabiensis* [12, 13] and *Anopheles stephensi* [14], as well as the emergence of diagnostic resistance in *P. falciparum* [15–17]. Armed conflicts across the region and population displacement due to drought further contribute to ongoing challenges in control and elimination efforts in the country. In spite of these overarching challenges, the current understanding of the malaria burden in the study area, encompassing its trends, seasonal patterns, and distribution, remains largely unexplored. Nevertheless, to guide national health services and assess progress toward malaria elimination, accurate evaluations of the burden, including trends, seasonal patterns, and distribution, are essential.

Therefore, the primary objective of the present study is to discern the prevailing trend and prevalence of malaria in the Metehara Health Center, situated in the East Shoa Zone of Ethiopia. This research aims to fill the existing knowledge gap and contribute valuable insights that can inform targeted interventions and strategies for more effective malaria control and elimination in the specified region.

Materials and Methods

Study area and study population.

The research was carried out at Metehara Health Center, situated in Metehara town at coordinates 8° 86' 95" N and 39° 92' 02" E, approximately 188 km to the East of Addis Ababa (Fig. 1). Metehara hosts an estimated total population of 21,348, with 10,763 men and 10,585 women [18]. Notably, the health center stands as the sole public health service provider in the town. Malaria is prevalent throughout the year, reaching peak transmission from September to December and experiencing the lowest transmission from April to May [19]. Both *P. vivax* and *P. falciparum* coexist, with *P. falciparum* being the predominant species. The study focused on individuals suspected of malaria who had sought medical attention at Metehara Health Center, examining blood films over the past six years from the 2017/18 to 2022/23 GC (2010–2015 E.C) periods.

Study design and data source

A retrospective study based on health facility records was undertaken, utilizing the laboratory registration logbook, to analyze the six-year trend of malaria prevalence at Metehara Health Center spanning from 2017/18 to 2022/23 G.C (2010–2015 E.C). The health center's malaria laboratory registration logbook served as the primary data source for this investigation. Data extracted from the logbook included information on diagnosed malaria cases, specifying months and years, identified *Plasmodium* species types, and socio-demographic details such as age and sex. The study encompassed all registered malaria blood film results, excluding only incomplete data and unreadable documents.

Data collection

Careful scrutiny of retrospective data spanning six years, from September 2017 to August 2023, regarding the trend of malaria prevalence was conducted using the laboratory logbook of Metehara Health Center in Ethiopia. Trained laboratory personnel collected the data through the utilization of a data extraction sheet. This sheet encompassed details such as the blood film result, *Plasmodium* species type (including *P. falciparum*, *P. vivax*, and mixed infections), examination specifics, year and month of diagnosis, as well as socio-demographic information of the patients.

At Metehara Health Center, the gold standard for confirming the presence of *Plasmodium* parasites and distinguishing between species was microscopic blood film examination, following the guidelines recommended by the World Health Organization (WHO). Malaria parasites were diagnosed in the laboratory using Giemsa-stained blood film, incorporating both thick and thin smears, in adherence to the country's standard operating procedures.

Data quality assurance

Initially, an evaluation was conducted to assess the comprehensiveness of the malaria registration books at the health facility, ensuring the reliability of the data. Subsequently, a dedicated data recording sheet was devised and employed to systematically capture the necessary information. Prior to data extraction, data collectors underwent thorough training on the extraction process. The investigators closely

supervised the entire data extraction procedure, randomly selecting a subset of completed data collection forms and scrutinizing each for accuracy, consistency, and completeness. A final manual recheck of all completed data was performed just before entry, and ultimately, the data underwent a thorough cleaning process in preparation for analysis.

Data Analysis

The gathered data were inputted into Microsoft Excel and subjected to analysis using Stata software version 14 (Stata Corporation, TX, USA). Descriptive statistics were employed to determine the frequencies and percentages of malaria prevalence across various parameters, including years, seasons, *Plasmodium* species, sex, and age. Microsoft Office Excel was utilized for the creation of descriptive figures, and the outcomes were presented through frequency distributions, tables, and graphical representations.

Result

Characteristics of study participants

During a six-year period from 2017/18 to 2022/23 G.C (2010–2015 E.C), a total of 59,250 Giemsa-stained malaria blood films were meticulously examined under a microscope to detect the presence of the *Plasmodium* parasite. Of the participants whose blood films were examined, 62.8% were males, while 37.2% were females. Analyzing the six-year trends, individuals aged between 25 and 54 years constituted the highest number of suspected and examined cases, totaling 22,751 (38.4%), followed by the 15–24 age group with 18,949 cases (31.9%). The age group > 35 years old had the lowest suspected cases, accounting for 1,485 (6.67%) of the total (Table 1).

Table 1
Socio-demographic characteristics of study patients, 2017/18–2022/23

Variables	Years						
	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	Total
Gender N (%)							
Male	3328 (69)	3618 (63.2)	4915 (65.4)	5322 (62.9)	7796 (64.8)	12,281(59.1)	37260 (62.8)
Female	1495 (31)	2103 (36.8)	2576 (34.4)	3132 (37.1)	4219 (35.2)	8465 (40.9)	21990 (37.2)
Age N (%)							
> 5 years	769 (15.9)	889 (15.5)	1002 (13.4)	694 (8.2)	1258 (10.47)	1813 (8.7)	6425 (10.8)
5–14 years	917 (19)	613 (10.7)	935 (12.5)	864 (10.2)	1674 (13.9)	2169 (10.5)	7172 (12.1)
15–24 years	1231 (25.5)	1732 (30.3)	2755 (36.7)	2117 (25)	3972 (33)	7142 (34.4)	18949 (31.9)
25–34 years	1423 (29.5)	2318 (40.5)	2134 (28.5)	4321(51.1)	4388 (36.5)	8167 (39.3)	22751 (38.4)
> 35 years	483 (10)	169 (2.95)	665 (8.9)	458 (5.4)	723 (6)	1455 (7)	3953 (6.67)
Total	**4823**	**5721**	**7491**	**8454**	**12015**	**20746**	**59,250**

Annual trends of malaria prevalence

Out of a total of 59,250 examined blood films, 10,636 (17.4%) were found to be positive for *Plasmodium* species over the six-year period. The number of malaria blood film examinations at the health center exhibited a progressive increase, with the highest number observed in 2022, closely followed by 2021. Despite an evident decline in the overall number of malaria cases over the past six years, dropping from 20.5% (993/4,823) in 2017 to 9.8% (1,176/12,015) in 2021, there was a sudden three-fold increase to 26.5% in 2022 compared to the previous year's 9.8% (Fig. 2).

Over these six years, the data reveals a consistent predominance of *P. falciparum*, representing the majority (74.3% (7,903/10,636)) of malaria cases throughout the observed period. *P. vivax* follows as the second most prevalent species (23.8%, 2,537/10,636), contributing a substantial but consistently lower proportion compared to *P. falciparum*. Additionally, mixed infections involving both *P. vivax* and *P. falciparum* exhibit a relatively minor presence (1.8% (196/10,636)), contributing the smallest proportion among the *Plasmodium* species. The graph visually depicts the fluctuation and composition of *Plasmodium* species, offering insights into the dynamic patterns of malaria infections at Metehara Health Center during the specified timeframe (Table 2; Fig. 3).

Table 2
Prevalence and Annual Trends of Malaria in Metehara Health Center, 2017/18–2022/23

Year	Blood film examined	No of positive	*Plasmodium* species		
			P. falciparum n (%)	*P. vivax* n (%)	*Mixed* n (%)
2017/18	4823	993 (20.5)	665 (67)	323 (32.5)	5 (0.5)
2018/19	5721	907 (15.8)	562 (61.9)	341 (37.5)	4 (0.44)
2019/20	7491	1068 (14.2)	822 (76.9)	238 (22.2)	8 (0.75)
2020/21	8454	983 (11.6)	609 (61.9)	360 (36.6)	14 (1.4)
2021/22	12015	1176 (9.8)	928 (78.9)	240 (20.4)	8 (0.68)
2022/23	20746	5508 (26.5)	4317 (78.3)	1034 (18.7)	157 (2.85)
Total	**59250**	**10636 (17.4)**	**7903 (74.3)**	**2537 (23.8)**	**196 (1.84)**

Fig: 3. Proportion of *Plasmodium* species at Metehara health center, 2017/18–2022/23.

Distribution of malaria with Age and Sex

Over the six-year span from 2017/18 to 2022/23, a total of 10,636 confirmed cases of malaria were reported, with 7,019 (66%) occurring in males and 3,617 (34%) in females. Notably, males consistently exhibited a higher annual rate of malaria cases compared to females (Figure. 4) Malaria cases were observed across all age groups, with the highest percentage (42%, 4,509/10,636) recorded in individuals aged 15 to 24. The age group of 25 to 34 had the second-highest percentage, accounting for 34.8% (3,702/10,636) of the total malaria cases (Figure. 5).

Seasonal distribution of malaria

Despite the observable variation in total malaria trends over the 6-year study period in the examined site, malaria cases persisted consistently throughout the year. Notably, the highest peak of cases occurred in October, while the lowest number of cases was reported in March. Throughout all months, infections attributed to *P. falciparum* reached their peak (Fig. 6). Analysis of seasonal data further revealed that the autumn season (September–November) had the highest percentage of malaria cases, accounting for 43% (4,526/10,636), whereas the lowest percentage, 13% (1,342/10,636), was recorded during the spring season (March to May) (Fig. 7).

Discussions

According to the current study, 10,636 cases (17.4%) of malaria were microscopically confirmed over the past six years. Despite the implementation of various control and elimination strategies [2, 3], a substantial malaria burden persists at the study site. Our findings align with comparable prevalence

reported in Dembecha [20], Kaffa zone [21], Sibu Sire [22], and Dembia [23], while differing significantly from studies in Bale Zone [24], Arjo-Didessa sugar development site [25], and Harari [26]. Notably, our results show lower prevalence compared to Mojo health center [6], Ataye [27], and University of Gondar Specialized Referral Hospital [7]. This variation may stem from differences in geographical location, demographic characteristics, and economic activities among study participants. Additionally, regional disparities in the implementation of malaria prevention and control measures in Ethiopia contribute to the observed differences. Although the incidence of malaria in Ethiopia has decreased, the pace varies across regions [2]. Furthermore, the observed variation may be influenced by the general public's knowledge of bed net usage, malaria transmission, and health-seeking behavior [7].

The current study reveals a steady decline in malaria cases from 2017/18 to 2021/22, consistent with findings from other locations [6, 28, 29]. However, an unexpected threefold increase in cases in 2022/23 raises concerns about a potential malaria resurgence in the study area. Government and stakeholders have intensified efforts in malaria prevention and control to meet national strategic plan goals [3, 4]. Community initiatives, including expanded indoor residual spraying, rapid diagnosis, increased access to insecticide-treated nets, and enhanced awareness, may have contributed to the earlier decline. Conversely, disruptions caused by the COVID-19 pandemic, ongoing conflicts, and unrest may explain the sudden surge in malaria cases in 2022/23. Drought-induced displacement and climate change could also contribute to malaria resurgence in Ethiopia [30]. These findings emphasize the importance of vigilant monitoring and surveillance of intervention strategies to avert catastrophic events and advance national goals of zero malaria incidence and mortality by 2030 [2, 3].

This study revealed that the prevalent *Plasmodium* species identified among participating patients was *P. falciparum*, consistent with Ethiopia's national malaria profile [3] and previous research in different regions [20, 23, 24, 26]. However, this contrasts with earlier studies that reported a higher prevalence of *P. vivax* species [6, 7, 28]. These differences may be attributed to the severity of *P. falciparum* infection, drug resistance, and agro-climatic variations.

The investigation revealed that males were more likely than females to test positive for malaria, possibly due to their outdoor working environments involving industrial, agricultural, and day labor activities coinciding with peak mosquito biting hours. This observation aligns with studies from various malarious parts of Ethiopia [6, 7, 20, 23, 25]. Additionally, the age group of 15–24 years exhibited the highest malaria prevalence, followed by the 25–34 age group, consistent with previous Ethiopian research [6, 7, 31]. This could be attributed to the outdoor nature of work in these age groups. In contrast, children under five years old showed a lower malaria prevalence, likely due to reduced mosquito exposure and the use of bed nets.

Regarding seasonal transmission dynamics, the study areas experienced year-round malaria cases, with the highest peak observed in autumn. This seasonal pattern is linked to the creation of stagnant water and higher relative humidity after the summer rainy season, providing an ideal breeding environment for

mosquitoes. The seasonality observed in this study aligns with findings in Modjo [6], Dembecha [20], Harari [26], and Ataye [27].

Limitation of the study

The study has limitations primarily related to the data source. Since the trend analysis relies on secondary data, the reliability of the information cannot be fully confirmed. Moreover, critical details such as participants' clinical presentations, body temperature, treatment and diagnosis history are not available, limiting a comprehensive understanding of individual cases. The absence of information on weather conditions throughout the months, seasons, and years, as well as participants' travel history to malarious areas, further restricts the contextual insights that could have been gained from these factors.

Conclusion

In conclusion, the study highlights malaria as a persistent health challenge in the area, with *P. falciparum* being the predominant parasite. The autumn seasons showed the highest peak of malaria cases. Notably, the disease disproportionately affects men over 15 years old, posing potential risks to the local subsistence economy. The observed five-year decline was followed by a sharp rise, indicating a malaria resurgence. This underscores the need for a revised strategy to sustain the gains achieved by the national malaria control plan.

Abbreviations

ACT, Artemisinin-based combination therapies; EC, Ethiopian calendar; EPHI, Ethiopian Public Health Institute; FMOH, Federal Ministry of Health; G.C, Gregorian calendar; P f, *Plasmodium falciparum;* Pv, *Plasmodium Vivax;* WHO, World Health Organization

Declarations

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Author Contributions

All authors participated in the conceptualization, study design, data analysis, and manuscript writing. They reviewed and provided final approval for publication, agreeing to be accountable for all aspects of the work. The final manuscript received unanimous approval from all authors.

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Availability of data

All data generated in this study are included in the manuscript.The data sets analyzed during the current study are available from the corresponding author on reasonable request.

Ethical consideration

The study received approval from the Institutional Review Board of the Aklilu Lemma Institute of Pathobiology, Addis Ababa University. Verbal consent was obtained from the relevant government official after discussing the study's purpose and methodology. Strict confidentiality measures were ensured, and the gathered information was exclusively utilized for this study.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests

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Figures

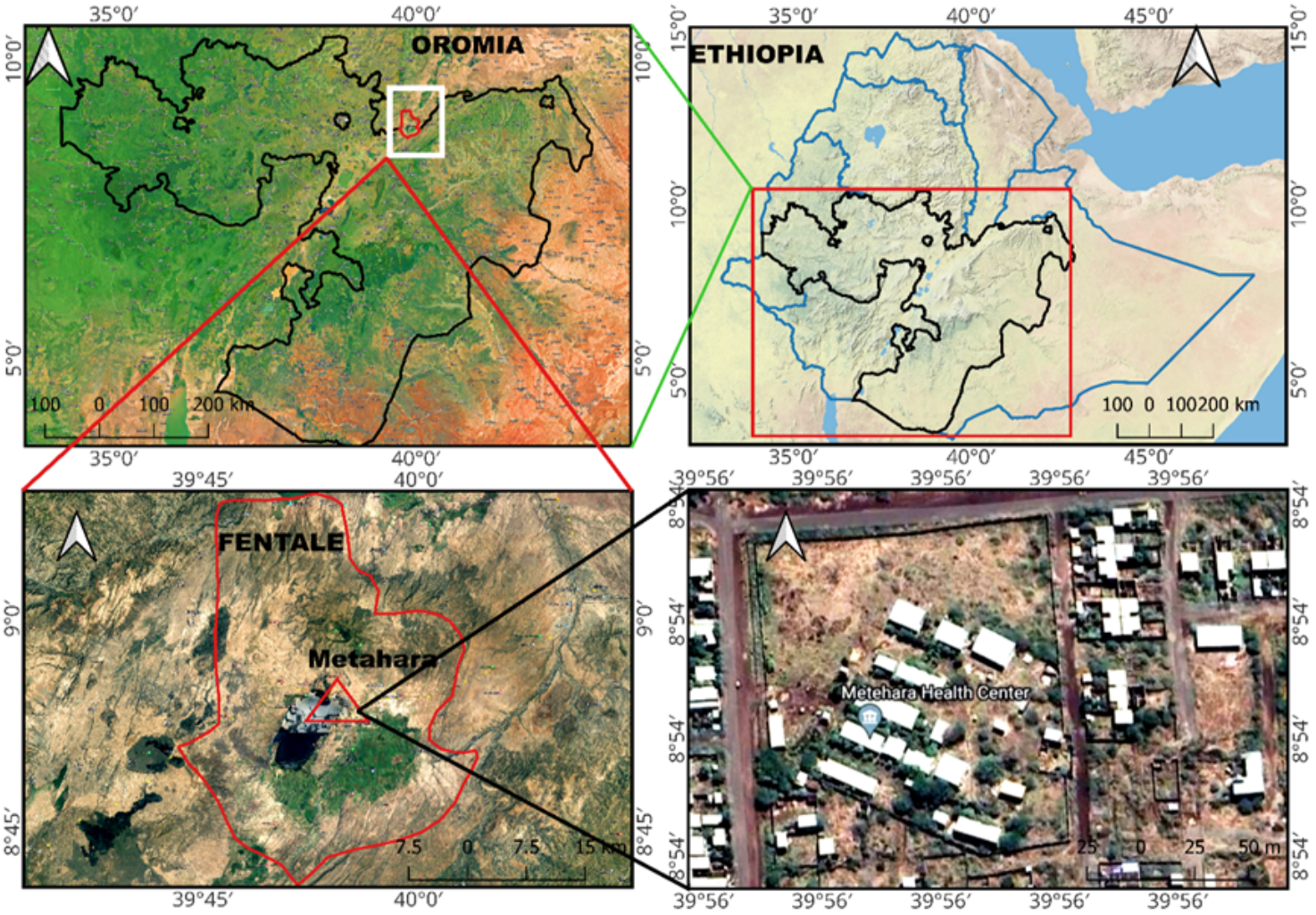

Figure 1

Map of study site in Ethiopia.

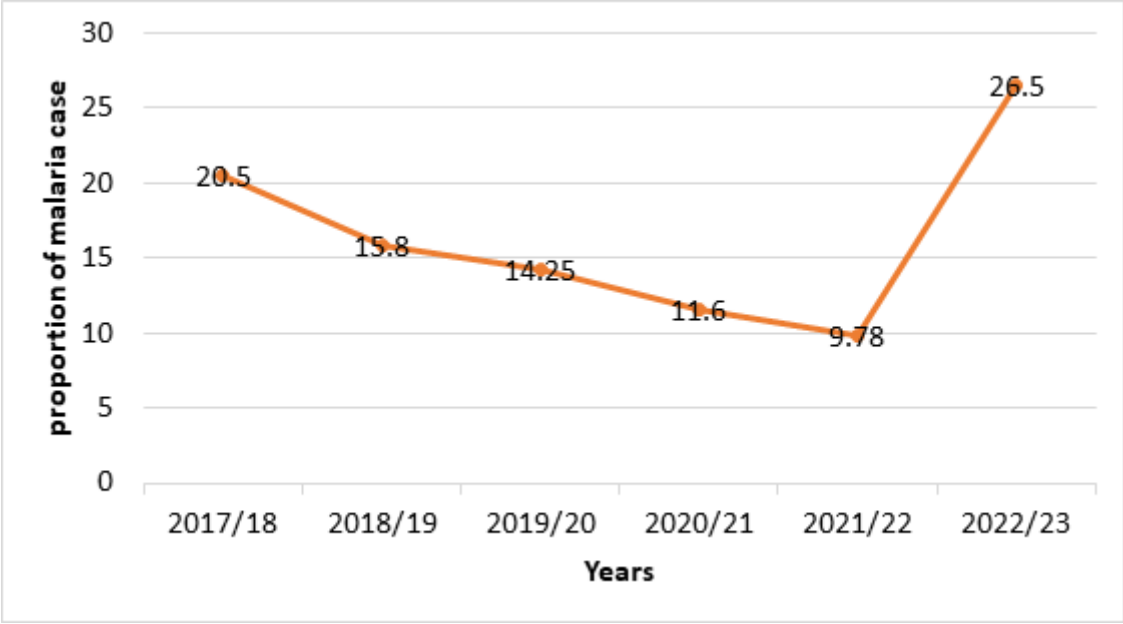

Figure 2

Annual trends of malaria prevalence at metehara health center, 2017/18–2022/23.

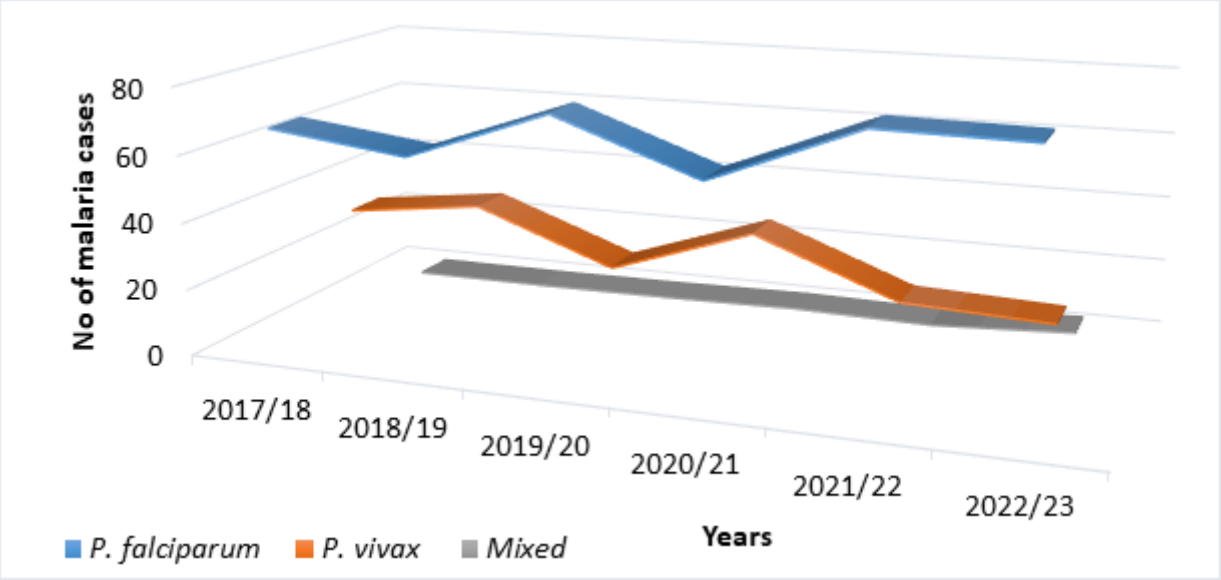

Figure 3

Proportion of *Plasmodium* species at Metehara health center, 2017/18–2022/23.

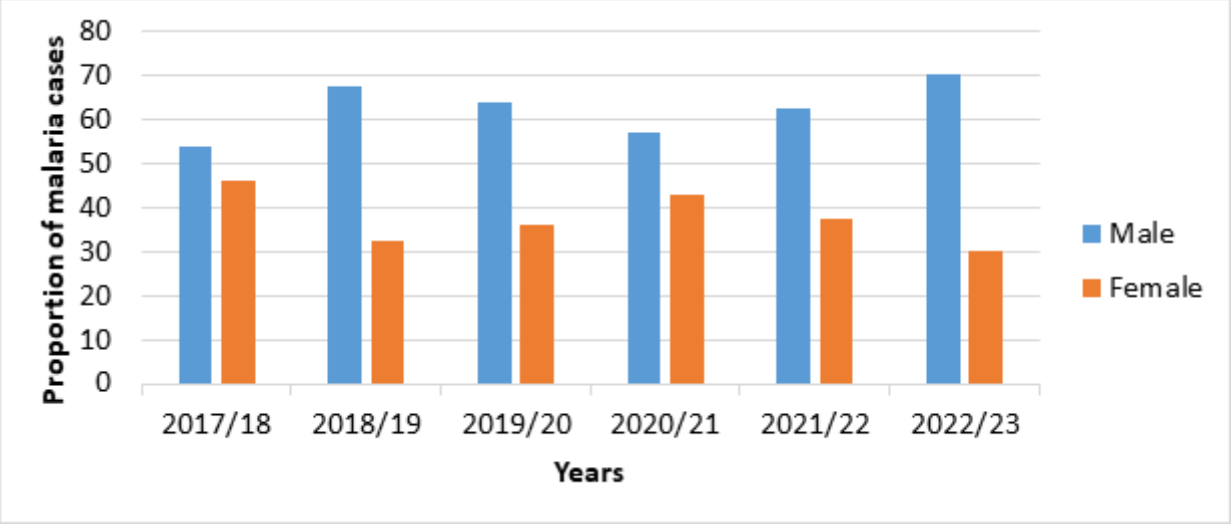

Figure 4

Annual trend of malaria by gender at Metehara health center, 2017/18–2022/23

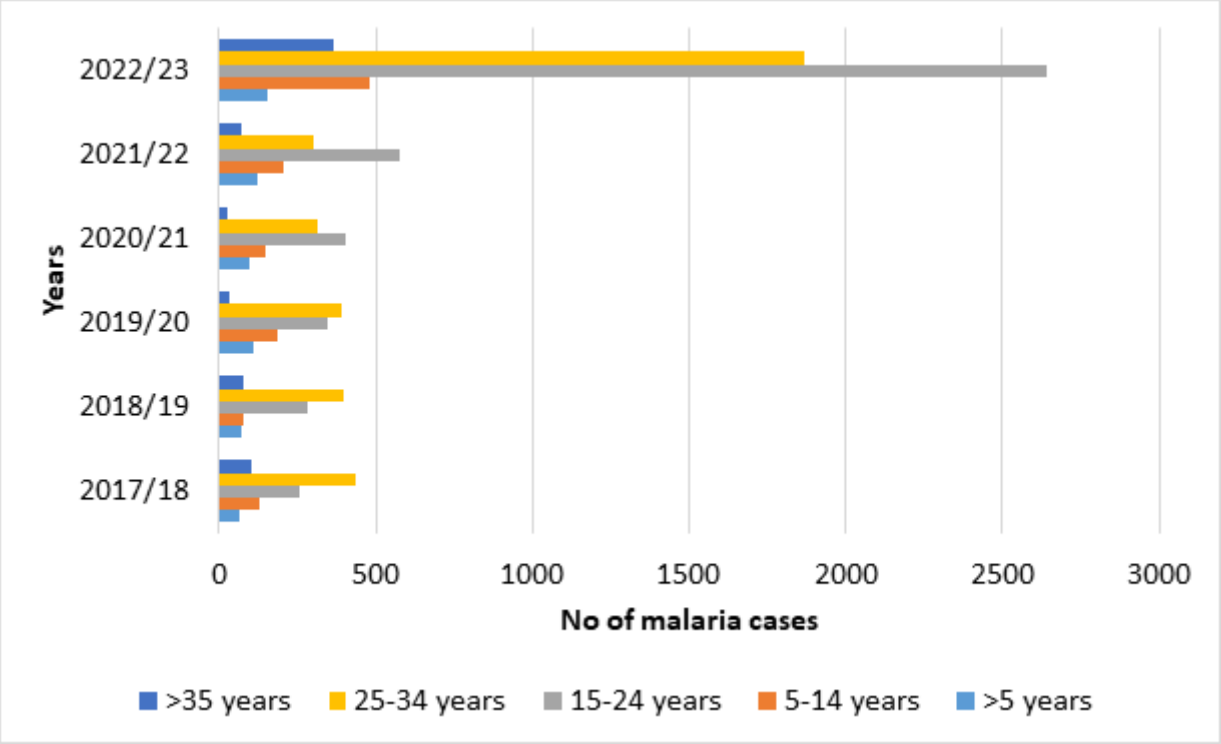

Figure 5

Annual trend of malaria by age group at Metehara health center, 2017/18–2022/23

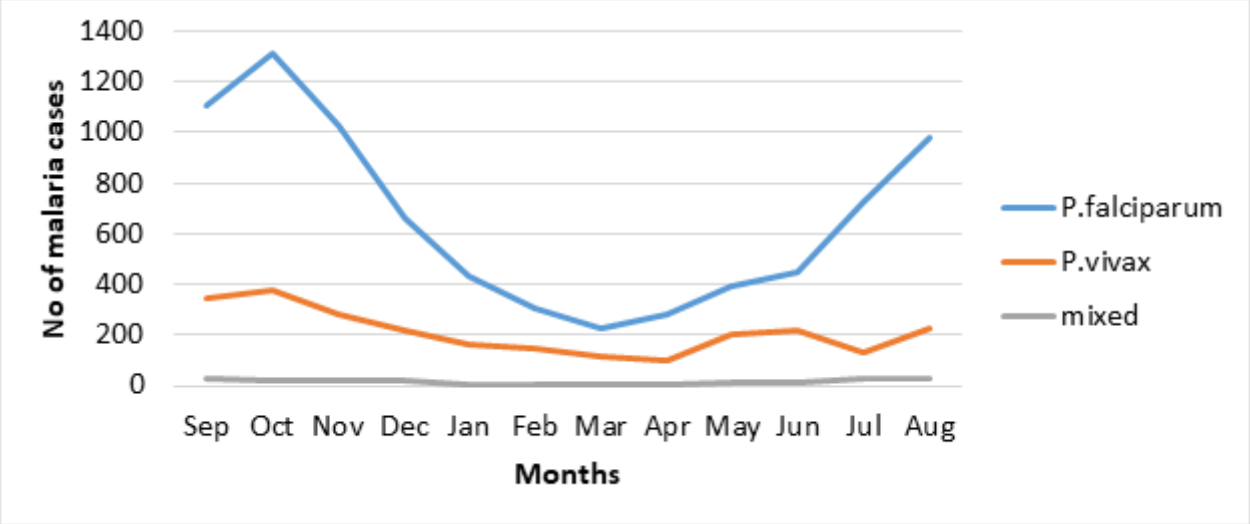

Figure 6

Annual trend of *Plasmodium* species by month at Metehara health center, 2017/18–2022/23.

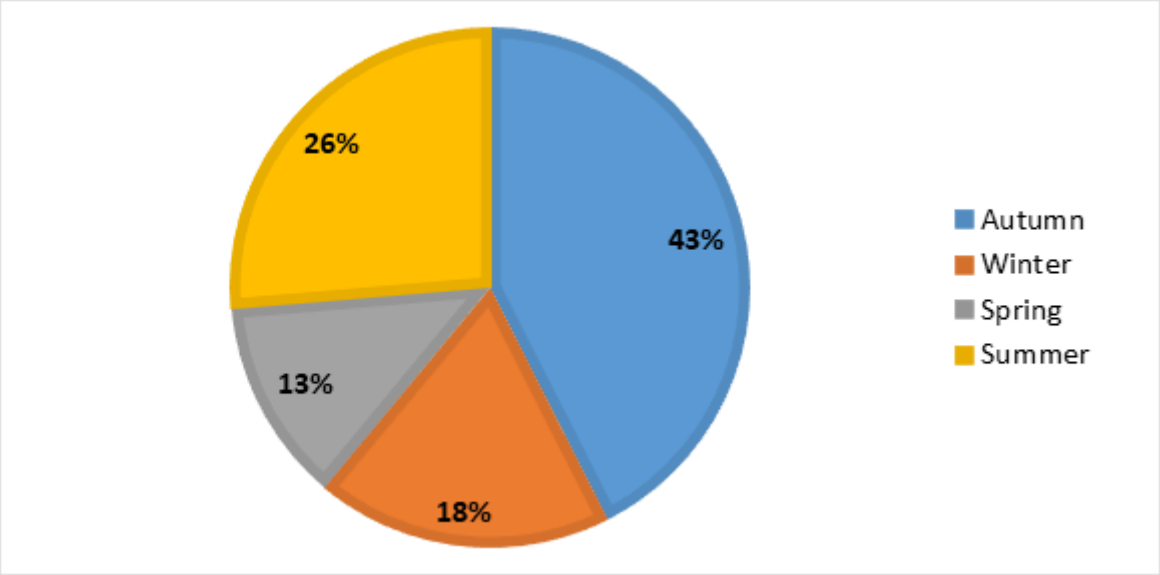

Figure 7

Seasonal malaria prevalence variations at Metehara Health Center (2017/18–2022/23)