A five year trend analysis of malaria prevalence in Guba district, Benishangul-Gumuz Regional State, Northwest Ethiopia: A retrospective study

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Shemsia Alkadir
Department of Zoological Sciences, Addis Ababa University

Tegenu Gelana
Shanghai Institute of Biochemistry and Cell Biology

Araya Gebresilassie
Corresponding Author
ORCiD: https://orcid.org/0000-0001-8795-6774

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Abstract

**Background:** In Ethiopia, malaria is a serious public health concern and has great impact on socio-economy. The trend analysis of malaria data from health facilities is useful for understanding its transmission dynamics and implementing evidence-based malaria control strategies. The aim of this study was to determine the trends of malaria infection in Guba district, northwest Ethiopia.

**Methods:** A retrospective study was undertaken at Mankush Health Centre, northwest Ethiopia. All malaria cases reported from 2014 to 2018 were carefully reviewed from the laboratory record books to determine the trends of malaria morbidity. Data were analyzed using SPSS version 20.0.

**Results:** In total, 16,964 malaria suspects were diagnosed using microscopy over the last 5 years, of which 8,658 (51.04%) were confirmed positive cases. *Plasmodium falciparum, P. vivax,* and mixed infection (both species) accounted for 75.2, 24.5% and 0.28% of the cases, respectively. Males patients were more affected (n=5,028, 58.1%) than female ones (n=3,630, 41.9%). Of the total confirmed cases, 60.4% were adults (≥ 15 years) followed by 22.6% of 5-14 years and 15.9% of under 5 years. High malaria prevalence was observed in spring (September to November) season, while the least was observed in autumn (March to May) with the prevalence of 45.6% and 11.5%, respectively.

**Conclusions:** The study demonstrated that malaria is a public health concern in the study area, wherein *P. falciparum* is the predominant species followed by *P. vivax.* Therefore, it is deemed necessary to enhance malaria detection skill of laboratory technicians and implement evidence-based malaria control and prevention activities to considerably reduce the burden of malaria in the study area.

**Background**

In Ethiopia, morbidity and mortality due to malarial infection have been considerably reduced over the last two decades. However, it is among the ten top leading causes of morbidity and mortality in children below five years [1]. About 75% of the landmass of the country is at risk of malaria, and 68% of the populations live in malaria risk areas [2].

The two parasite species, *Plasmodium falciparum* and *P. vivax,* are the predominant parasite species in Ethiopia, constituting 60% and 40% of malaria cases, respectively [3, 4]. The malaria transmission
in the country occurs mainly at altitudes < 2000 m, albeit endemic regions > 2000 m have been reported [5]. The levels of malaria risk and transmission intensity show marked seasonal, inter-annual and spatial variability; with the exception of the southwestern international border low land area where transmission is year-around [6]. In most regions of Ethiopia, the peak malaria transmission occurs in general during the months of September to December, following the main rainy season from June to September [7]. The unstable transmission patterns make the country prone to cyclic epidemics occurring every 5 to 8 years [2, 7]. However, information is scarce on malaria transmission pattern in some endemic areas of Ethiopia, including various districts of Benishangul-Gumuz Regional State, which is essential for implementing evidence-based intervention.

Risk of malaria is highest within the Benishangul-Gumuz Regional State, in which 98% of the landmass is prone to malaria transmission [8]. This has been evidenced by the high number of malaria cases between July 2014 and June 2016, accounting 57.5%, of that 78.4% and 21.6% were *P. falciparum* and *P. vivax* malaria parasites, respectively [9]. Another study in Yasso district within the region additionally showed that 75% of the study subjects were positive for malarial parasites [10]. Prominently, a total 54,197 malaria cases and seven deaths were recorded from July 2013-June 2017 [11]. In spite of the general public health significance and also the widespread incidence of malaria in several districts of the region, the general trend of malaria prevalence has not been thoroughly studied in particular in Guba district. Analyzing the morbidity pattern of malaria in endemic areas of malaria would help to understand the dynamics of disease transmission and to evaluate the effectiveness of proven malaria control interventions to curb the disease burden in a locality.

Therefore, the present study aimed to assess the prevalence and trends of malaria infections in Mankush Health Center, northwest Ethiopia from 2014 to 2018.

**Methods**

**Study area**

A health facility-based retrospective study was undertaken in Mankush Health Center, northwest Ethiopia. Mankush Health Center is found in Guba district, Benishangul-Gumuz Regional State. The Guba district is located 889 kilometer northwest of Addis Ababa. The district lies at between 34°30’ to
37°15′E longitude and 10°54.8′ to 12°22′N latitude. The area had a mean temperature of 26 °C and an annual rainfall of 1,323 mill liters over the last 20 years (Ethiopian Meteorology Agency, unpublished data). The district has an estimated total population of 10,851, of whom 5,305 are men and 5,546 are women [12]. Public and private health facilities offer primary healthcare service to the society in the district.

Study design and population
A health facility-based retrospective study was conducted to determine the trends of malaria morbidity during the last 5 years (2014-2018) at Mankush health center. The study populations were all malaria suspected individuals who had complains of febrile illness in Mankush health center throughout the study period.

Inclusion and exclusion criteria
The study data including number of malaria cases diagnosed in months and years, types of malaria species identified, and socio-demographic data (age and sex) were included within the analysis notwithstanding age, pregnancy and other infection status. Any data with incomplete records of important variables and examination results were excluded from the study.

Sample size
All of the 16,964 malaria suspected patients registered between January 2014 and December 2018 within the laboratory logbook that fulfilled the inclusion criteria were taken to work out the trend of malaria prevalence in the study area.

Data collection
Five year retrospective data on the trend of malaria prevalence was obtained from Mankush Health Center for the period of 2014-2018. In the health center, microscopy was used as the gold standard to confirm Plasmodium parasite presence by examination of peripheral smears of stained blood films throughout the country. Blood smear preparation, staining and blood film examination for malaria parasite detection were done in accordance with a standard operating procedure of WHO protocol. Individual data such as total clinically treated, confirmed cases in month and year, species of parasites, and socio-demographic data (age, sex) were collected from 2014 to 2018. Any data like the socio demographic, malaria diagnosis results that are not properly documented were excluded.

Data quality control
Retrospective data for this study were collected from malaria morbidity registration books health center. Data was collected by trained laboratory technicians, and the entire process, data collection and data entry were daily supervised by principal investigator so as to ensure the completeness and consistency of the data.

**Statistical analysis**

All data were checked for their completeness. Statistical analyses were carried out using SPSS statistics, version 20 for Windows (SPSS Inc., Chicago, IL, USA), and Microsoft® Office Excel 2007. Descriptive statistics was used to show the trends of malaria transmission in terms of seasons, years, gender, age and species of malaria parasite. Chi square test was also applied to compare the trend of malaria prevalence between male and female patients. Altogether, $P < 0.05$ was considered as statistically significant. The analyzed data was presented using tables and figures.

**Results**

**Annual trends of malaria prevalence**

A total of 16,964 blood smears were prepared and examined from malaria-suspected patients at Mankush Health Center during the past five years (2014–2018) (Table 1). Out of these, 8,658 (51.04%) were microscopically confirmed malaria cases. The highest number of malaria cases 2,236 (34.95%) and the lowest 1,352 (85.03%) malaria cases were recorded in 2018 and 2014, respectively (Table 1). In overall, the trend in the prevalence of malaria over the five years exhibited peak incidence in the year 2018, with a steady increase in the number of malaria cases through 2014 to 2018.

| Year | Total Number of Blood Smear Examined | No. of Positive Malaria Smear (%) |
|------|-------------------------------------|----------------------------------|
| 2014 | 1,590                               | 1,352 (85.03)                    |
| 2015 | 1,838                               | 1,424 (77.48)                    |
| 2016 | 2,557                               | 1,579 (61.75)                    |
| 2017 | 4,581                               | 2,067 (45.12)                    |
| 2018 | 6,398                               | 2,236 (34.95)                    |
| Total| 16,964                              | 8,658 (51.04)                    |

**Prevalence of malaria cases in relation to sex and age**

Table 2 shows the number of confirmed malaria cases by sex over the last 5 years. A statistically significant variation ($\chi^2 = 284.15$, $d.f. = 1$, $P < 0.0001$) in malaria prevalence was observed among sex. Out of 8,658 confirmed malaria cases, 5,028 (58.1%) and 3,630 (41.9%) were reported in males
and females, respectively, with a male to female ratio of 1.39. For each year, the numbers of malaria-positive males were higher than that of females.

| Sex      | Total cases examined | Slide positive No. (%) | P. falciparum No. (%) | P. vivax No. (%) | Mixed No. (%) |
|----------|----------------------|------------------------|-----------------------|------------------|--------------|
| Male     | 9778                 | 5028 (51.8)            | 3767 (74.92)          | 1246 (24.78)     | 15 (0.29)    |
| Female   | 7186                 | 3630 (41.9)            | 2746 (75.64)          | 875 (24.07)      | 9 (0.25)     |
| Total    | 16964                | 8658                   | 6513 (75.22)          | 2121 (24.49)     | 24 (0.28)    |

The distribution of parasite species in relation to age is shown in Fig. 1. Malaria was reported in all age groups, but the age group ≥ 15 years were more affected, with a prevalence rate of 5228 (60.4%), followed by 5–14 years old and under five children with prevalence rates 1955 (22.6%) and 1375 (15.9%), respectively. In relation to *Plasmodium* spp., *P. falciparum* was the predominant parasite in all age groups and it was higher in the ≥ 15 years and 5–14 age group with a prevalence rate of 4155 (79.5%) and 1346 (58.4%), respectively. The age group ≥ 15 was more affected by *P. vivax* 1058 (20.24), followed by 5–14 year olds, 600 (30.7%) and below 5 year 363 (26.4%).

*Plasmodium* species distribution

*Plasmodium falciparum* and *P. vivax* were the only species in study area, where *P. falciparum* accounted for 6,513 (75.23%) of the overall prevalence, followed by *P. vivax* constituting 2,121 (24.50%). Mixed infection (*P. falciparum* + *P. vivax*) accounted only for 24 (0.28%) of the total cases.

In the five year trend, *P. falciparum* was threefold more dominant than *P. vivax* (75.23% vs. 24.50%). The prevalence of *P. falciparum* slightly declined from 77.96% in 2014 to 74.74% at the end of 2018, (Fig. 2). However, the prevalence of *P. vivax* which was 21.82% at the beginning of the study (2014) slightly increased to 24.82% the same period, with the highest rate (27.74%) in 2015.

Malaria trend by season

The seasonal distribution of malaria cases is summarized in Fig. 3. Though malaria occurred in all seasons, the prevalence had fluctuating trend across the four seasons over the last 5 years. The highest and the lowest cases of malaria were observed during spring (September, October and November) (45.6%) and autumn (March-May) (11.5%), respectively. Higher number of cases of *P. falciparum* was observed in spring and summer, while more cases of *P. vivax* were observed in spring, followed by winter (Fig. 3). However, the minimum number of *P. falciparum* and *P. vivax* cases were observed during autumn (March-May).
Discussion
The results of the present study indicated that malaria is a major health burden in the study area, with total slide positivity rate of 51.04% over the past five years (2014 to 2018). This result was higher than overall malaria positivity rates (21.8–39.6%) reported from other similar retrospective studies conducted in northwest, southern, south-central and western Ethiopia [11, 13, 14, 15]. This observed variation in malaria prevalence might be due to the poor quality of laboratory diagnosis, less community awareness, inequitable health workforce deployment, microclimate variation, altitudinal variation, expansion of development projects like dams or irrigation, malaria prevention activities, and insecticide and drug resistance. Malaria cases trend in the present study appears non-fluctuating as microscopically confirmed cases demonstrated a steady increase from 2014 to 2018 throughout all the five years. An increase in the number of malaria cases occurred through 2014 and 2018, with a maximum number reported in 2018. This finding is in disagreement with similar retrospective studies in Ethiopia [11, 13, 15]. While the overall malaria morbidity declined over the past 15 years in Ethiopia [16], the number of malaria cases steadily increased throughout the study period in the area. This could be related to the inconsistent implementation of malaria prevention and control strategies. Overall, the finding indicated that there is still malaria burden in the study area, which calls for comprehensive effort on awareness creation, budget increment and deployment of effective malaria prevention and control options.

Our data also showed that that malaria cases due to *P. falciparum, P. vivax* and their mixed infection accounted for 75.2, 24.5% and 0.28% of the cases, respectively. This finding is in agreement with malaria species distribution in different parts of Ethiopia, which reported the predominance of *P. falciparum* over *P. vivax* [2, 11, 13, 17]. Nevertheless, these findings are less than similar reports from Metema area, northwest Ethiopia (91%) [18], and sub-Saharan African countries, where 99.7% of estimated malaria cases were due to *P. falciparum* [3]. The study also revealed higher positivity rate of malaria among males (58.1%) than females (41.9%). This finding is are in accordance with the reports of previous studies undertaken in different parts of
Ethiopia, which reported higher malaria prevalence in males than females [13, 19, 20]. The higher prevalence rate might be due to the fact that in the present study area males are often engaged in early night outdoor agricultural and day labor activities which make them more prone to infective mosquito bites as compared to females counterparts which are mostly at homelands protected from such infective [21]. Evidences showed that much greater mosquito human-biting activities occurred outdoors than indoors and through early parts of the night, suggesting higher outdoor malaria transmission potential in Ethiopia [22].

Distribution of malaria cases in relation to age showed that great majority of cases was among adults age 15 years and above followed by the age group of 5–14 years and under five children. Such results have been reported by other studies [13, 20], where males in this age group are susceptibility to malaria infections. In this rural area, agriculture is the main livelihood, where males in the reproductive age group (≥ 15 years old) is engaged in agricultural activities often during the night time. Farming is relatively wide-ranging in the study area that large numbers of young, non-immune migrant laborers move to the area from different parts of the country for agricultural activities, which indeed increase the risk of contracting malaria infection. In addition, because of the hot weather condition, males have a habit of staying outside their home and sleep under big trees during night and exposed to the infective mosquito bites. Prominently, the observed lower prevalence of malaria in children under 5 years of age might be because of their less likely exposure to infected mosquito bite due to good awareness and practices of their parents/care takers on malaria control and prevention activities.

The prevalence and magnitude of malaria transmission are mainly determined by environmental, climatic and seasonal factors. In this particular study, the highest cases of malaria were observed during spring (September, October and November). This finding is in agreement with other reports from different parts of Ethiopia [17, 19, 20], which showed the highest peak of malaria in the months of September, October and November. In most regions of Ethiopia, the main malaria transmission season is from September to December, following the rainiest season from June to September [7]. Variability of rainfall and temperature in each season affects the availability of breeding habitats for
mosquito vectors, the length of mosquito larvae development and the rate of growth of the malaria parasites inside the vector [23, 24]. Similarly, there was a second peak in malaria case during summer (June to August). Possibly, this is due to relapsing behavior of some malaria parasite and irregular rain-full in the area.

Conclusions
In conclusion, the study demonstrated that malaria remains a public health burden in the area, which needs due attention and further comprehensive interventions. The deadly *P. falciparum* appeared to be the dominant *Plasmodium* species, and individuals age 15 years and above, and males were more infected. In addition, malaria transmission in the area peaks from September to December, coinciding with the major harvesting season. Therefore, it is imperative to enhance malaria detection skill of laboratory technicians and put in place evidence-based malaria control and prevention activities to considerably reduce the burden of malaria in the study area.

Abbreviations
SPSS: Statistical Package for the Social Science; WHO: World Health Organization

Declarations

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Authors’ Contributions
SK and TG conceived the study and involved in the data collection. SK, TG, and AG were involved in the data analysis, preparation and critically reviewing the manuscript. All authors read and approved the final manuscript.

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Not applicable.

Availability of data and materials
All data underlying the findings are available from corresponding author on reasonable request. All relevant data are within the manuscript.
**Ethics approval and consent to participate**

The five year data was collected after ethical clearance was obtained from Ethics Committee of Department of Zoological Sciences, Addis Ababa University. After having a discussion about the purpose and method of the study, verbal consent was obtained from the Head of the district Health Bureau before the data collection.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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Figures
Figure 1

Distribution of Plasmodium species by age groups at Mankusha Health Center, western Ethiopia: (2014-2018)
Figure 2

Species trends of malaria parasites in Mankusha Health Center, western Ethiopia: (2014-2018)
The distribution of Plasmodium species in different seasons in Mankush heath center from 2014-2018