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Original Research Article

Six years trend analysis of malaria prevalence in lower Blue Nile Valley, Metekel Zone, Northwest Ethiopia: an implication towards malaria control in development project areas

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Abstract

Background and objective: Malaria is a life-threatening disease remaining public health problem in Ethiopia in general and Metekel zone in particular. To design and implement evidence-based effective malaria control strategies, understanding its transmission dynamics through trend analysis of health facilities' data is important. The objective of this study was to investigate the trends of malaria distribution in selected districts of Blue Nile valley in Metekel zone.
Methodology: Six years retrospective study was conducted at in lowest Blue Nile valley, Metekel zone. History of all patients visited the aforementioned institutions from 2014 to 2019 were reviewed. Malaria parasites confirmed slides on the laboratory registration books were carefully revised to assess the trends of malaria infections. Data were entered into excel computer program and analyzed using SPSS version 16.0.
Result: Out of a total of 542,419 patients diagnosed in the three districts' health facilities, within six years, 369,065 (68.04%) were confirmed malaria parasite positive cases. The highest malaria positivity rate (n=156, 860, 82.39%) was reported from Dangure health institution which is greater than the sum result of both Pawe and Mandura. *Plasmodium falciparum* and *P. vivax* accounted for 63.75% and 33.60% respectively, while 2.64% were found to be mixed infection of both species. Males were more affected 213,014 (57.71%) than female 156051 (42.28%).
Conclusion: The current study concluded that malaria remain a public health problem, in which the deadly malaria parasite, P. falciparum is the predominant species in the area.
Keywords: Blue Nile Valley, Ethiopia, Malaria, Mega projects, Metekel zone, prevalence.

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1. Introduction

Malaria is endemic in about 106 countries and continues to be one of the leading causes of morbidity and mortality throughout the world the majority being children under the age of five [1,2]. Malaria remains an important public health problem in Africa because of the presence of most efficient vectors, *Anopheles gambiae* complex and *An. funestus*. *An. gambiae* complex comprises 8 sibling species of which *An. gambiae*, *An. coluzzi* and *An. arabiensis* are the most known and important malaria vectors. *An. gambiae* is relatively long-lived, highly anthropophilic, with short larval development time and use mostly larval habitats made of anthropogenic activities [3].

Malaria is the leading causes of morbidity and mortality in Ethiopia and 75% of the land of Ethiopia is malarious. More than 60% of the total populations of Ethiopia are at malaria risk and 54 (6.4%) districts have high transmission. According to Alemu *et al*., (2012) [4] health indicator report, 69.2% of the cases of malaria in northern part of the country is by *P. falciparum* where as 30.2 % were confirmed to be due to *P. vivax*.

In Ethiopia, there are more than forty species of *Anopheles* mosquitoes [5], of which *An. arabiensis, An. funestus, An. pharoensis* and *An. nili* are the malaria vectors [6-9]. *Anopheles arabiensis* is primary malaria vector in Ethiopia. Likewise, *An. funestus* and *An. pharoensis* are secondary vectors occurring with varying population

densities, limited distribution and vector competence [10]. Based on the principle of National Strategic Plan of Ethiopia, malaria control programs are ongoing with various intervention strategies to reduce malaria burden to a level where it is no longer public health problem [11-14]. In spite of considerable progress in malaria control, the infection remains a severe public health problem. *Plasmodium falciparum* and *P. vivax* are the dominant malaria parasites responsible for the majority of cases in the country [12, 15].

According to the malaria indicator survey 2017 of the country, areas with the highest malaria transmission risk as stratified by Annual Parasite Incidence (API) appear to be largely high in the lowland and midlands of western border with Sudan and South Sudan [16]. According to the report, malaria transmission in Ethiopia is seasonal, lasting for about three years usually from September to November except in western part of the country where the largest Blue Nile Valley lies. In this area, malaria transmission exceeds to six months after the main rainy season.

The Benishangul Gumuz regional state health bureau report shows that 99% of the land is malarieous that the community suffers from stable and endemic malaria. Similarly, the FMOH MIS, (2011)[10] data indicated that the districts located in lower Blue Nile valley, Benishangul Gumuz region are the most malaria affected areas with 18.4% prevalence while the national prevalence was 1.2%. Similarly, the API level of the region is 236.6 while the national API level is 27.7. Attributable to conducive environmental conditions such as arid and semi-arid geo-environmental settings, lower altitude and high humidity for vector and parasite development, malaria remains a major public health problem in the study area. Similarly, anthropogenic factors, such as mega water resource development, agro-development and mining projects play a great role in malaria prevalence in Metekel zone.

Therefore, having complete malaria data before and during construction of the Great Ethiopian Renaissance Dam is important to develop effective control strategies after the water resource project which may create breeding sites for malaria vector. The objective of this study was to assess the trends of malaria infection among patients attending health institutions in three districts in Blue Nile Valley, western Ethiopia within last six years.

2. Materials and Methods

2.1 Study area Descriptions

The study was conducted in three districts in lower Blue Nile valley, Metekel zone during the construction of Great Ethiopian Renaissance Dam. Metekel zone is one among the three administrative zones of Benishangul Gumuz Regional State and it is an area where Great Ethiopian Renaissance Dam is being commissioned.

The area is situated at 588 km from Addis Ababa towards western part of Ethiopia. The study sites have dry and hot climate with average annual temperature of 25 ºC to 37ºC and rainfall of 800 mm to 1300 mm (unpublished report of zone metrological office). Its altitudinal settings range from lowland of 750m to highland of 2700 m above sea level. The largest African river, Blue Nile and other tributary rivers such as Gilgel Beles, Abat Beles, Dura, Shar, Gorshi and other perennial rivers are located in the study area.

The study districts have an estimated population totaled to about 300266, of whom 120,106 (40%) are males and 180,160 (60%) are females. The majority of the populations are subsistent farmers while the rest are merchants and civil servants (personal communication with zone administrative office). The study districts include Dangure, Pawe and Mandura districts. The data were collected from Hospitals, Health stations, Health posts and health centers.

2.2 Study Design

A surveying study of malaria trends was conducted to assess the distribution of malaria infection with hindsight study of six years registration laboratory logbook during 2014 up to 2019. The data were blood film identification of malaria reports at the health institutions.

2.3 Study population, data collection and analysis

The target populations for the study were all populations who have been diagnosed at the health institutions in Dangure, Pawe and Mandura districts during the study period. Six years malaria data were extracted from laboratory registration book by using data collection sheet. Socio demographic condition, spatial location and year and month of laboratory examination, total number of blood film examined, and *plasmodium* species (*P. falciparum*, *P. vivax* and mixed infections) were collected from registration books of the patients.

In health institutions, microscopy is a standard technique to detect *Plasmodium* parasites and identification of the species. Using WHO protocol, both thin and thick blood films were prepared from clinically suspected patients. After airdrying and fixing with absolute methanol, both thick and thin films were stained by using Giemsa solution. Then specimens were examined for *Plasmodium* parasites using 100× oil immersion microscopically.

Data were entered into computer program and checked for completeness. Then it was analyzed using SPSS software. Microscopically confirmed malaria cases with months and years were analyzed by descriptive statistics. Specifically, the temporal distribution of *plasmodium* species in each month and year with confirmed cases was briefed using table. Also, Chi-square test was employed to determine the association of malaria parasite species with sex, age group, month of occurrence and residence. Malaria prevalence was calculated by dividing

the number of malaria parasite positive people to the total number of study subject. Tables were used to illustrate the overall trends of malaria.

3. Results and Discussion

3.1 The distribution of malaria in lower Blue Nile Valley, Metekel zone, Northwest Ethiopia from 2014-2019

In this study, a total of 542,419 blood samples were examined at health institutions in three districts in lower Blue Nile valley, Metekel zone from 2014 -2019 years. From the blood film samples, 369,065 (68.04%) were microscopically confirmed as malaria cases. As indicated in Table 1, the highest malaria prevalence was recorded from Dangure 156,860 (82.39%) followed by Pawe district 106,406 (63.72%) and the least malaria cases 105,799 (56.15%) were recorded from Mandura district which is statistically significant ($\chi 2=292.12$, df=1, $P<0.05$).

Table 1: Distribution of malaria infection in three districts in lower Blue Nile valley, Metekel zone, Northwestern Ethiopia from 2014-2019 years

Study districts	Total number of people tested			Number of parasite positive			
	Male	Female	Total	Male	Female	Total	Percentage
Dangure	91744	93643	185387	99532	57328	156860	82.39%
Mandura	92312	96096	188408	54852	50947	105799	56.15%
Pawe	89632	78992	168624	58630	47776	106406	63.72%
Total	273688	268731	542419	213014	156051	369065	68.04%

3.2 Trends of malaria prevalence in lower Blue Nile Valley, Northwestern Ethiopia from 2014-2019 years

Out of a total of 542,419 malaria suspected patients visited health facilities in the three districts in Metekel zone within six years (2014-2019), 369,065 were found to be malaria positive. In average 61, 511 malaria cases were recorded annually. As shown in Table 2, the number of malaria cases were slightly decreased from 2014 to 2017, and then sharply grown from 2017 to 2019. The highest malaria prevalence 68347 (18.52%) in the three districts of Metekel zone was recorded in the year 2019 followed by 2014 which accounts 66,992 (18.15%). Comparatively, lowest malaria prevalence 48493 (13.14%) was observed during 2013.

Table 2: Annual trends of malaria prevalence in three districts in lower Blue Nile valley, Metekel zone from 2014-2019

Study Sites	**Study years**						
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	Total
Dangur	21706	28232	23952	20223	27406	35341	156860
Mandura	13575	17886	18817	12916	20815	21790	105799
Pawe	31711	19801	18463	15354	9861	11216	106406
Total	66992 (18.15%)	65919 (17.85%)	61232 (16.59%)	48493 (13.14%)	58082 (15.73%)	68347 (18.52%)	369065 (100%)

3.3 Trends of malaria infection in relation to sex and age

The frequency of malaria parasite positive slides in relation to sex and age within the last six years trend analysis is indicated in Table 3. The variation of malaria prevalence observed between sex was statistically significant ($\chi 2=285.21$, df=1, $P<0.05$). Out of 369,065 microscopically confirmed malaria cases, 213,014 (57.71%) and 256,051 (42.28%) were detected in males and females, respectively. In each study site, the statistics of malaria-positive males were higher than that of females with overall 1.36:1 male to female ratio. Regarding the patients' age-malaria infection analysis, highest malaria cases 185260 (50.19%) were investigated to be in under five years old children followed by 5-15 age group 110,234 (29.87%) in all study sites.

Table 3: Trends of malaria prevalence among different age structures and sex in three districts in Metekel zone, lower Blue Nile Valley, Northwestern Ethiopia.

Age	**Male**	**Female**	**Total**	**Percentage**
<5	93583	91677	185260	50.19%
5_15	67831	42403	110234	29.87%
>15	51600	21971	73571	19.93%
Total	213014 (57.71%)	156051 (42.28%)	369065	100%

3.4 *Plasmodium* parasites and their spatial distribution in lower Blue Nile valley, Metekel zone Northwestern Ethiopia from 2014-2019

Out of all *Plasmodium* species, *P. falciparum* and *P. vivax* were found to be malaria causative agents in all study areas. The statistical analysis shows that *P. falciparum* was found to be predominant parasite 66.2%, while *P. vivax* and the mixed infection were 31.54% and 2.25% respectively.

Table 3: Spatial distribution of *plasmodium* parasites in Metekel zone, lower Blue Nile valley from 2014- 2019

Study areas	*Plasmodium* parasite			
	P. falciparum	***P. vivax***	**Mix cases**	**Total**
Dangure	98819 (63%)	54204(34.5%)	3837 (2.44%)	156860
Mandura	66124 (62.5%)	36363 (34.37%)	3312 (3.13%)	105799
Pawe	70341 (66.20%)	33460 (31.54%)	2605 (2.25%)	106406
Total	235284 (63.75%)	124027 (33.60%)	9754 (2.64%)	369065

3.5 Seasonal distribution of malaria infection in lower Blue Nile Valley from 2014-2019

The analysis indicated that despite the apparent fluctuation of prevalence of the disease in the study area, malaria infection occurred in almost every season of the years (Table 5). The current study revealed that the peak malaria infection was observed after the long rainy season (Sept- Nov) with prevalence of 146, 147 (39.6%) followed by rainy season (Jun – Aug) and before long rainy season (Mar – May) with prevalence of 92,982 (25.2%) and 75415 (20.4%) respectively.

Table 5: Seasonal variations of *plasmodium* infection in lower Blue Nile valley from 2014- 2019 years

Seasons of the years	Study years							
	2014	**2015**	**2016**	**2017**	**2018**	**2019**	**Total**	**Percentage**
De –Fe	8703	9359	8514	7439	9677	10829	54521	14.8%
Mar –May	14771	11960	12332	10862	11853	13637	75415	20.4%
June-Aug	18542	16870	15009	11662	13858	17041	92982	25.2%
Sep –Nov	24976	27730	25377	18530	22694	26840	146147	39.6%
Total	66992	65919	61232	48493	58082	68347	369065	100%

4. Discussion

The study shows that the prevalence of malaria was variable spatio-temporally with overall prevalence of 68.04%. The highest malaria positivity rate (n=156, 860, 82.39%) was reported from Dangure health institution which is greater than the summed result of Pawe and Mandura. Although it shows relative downward trend over the years, it exhibited fluctuations constituting a prevalence of high category (>30%) in all study years from 2014 to 2019 indicating that the area experiences the epidemic malaria. This is significant indicator for the presence of endemic malaria in lower Blue Nile valley, Metekel zone, northwest Ethiopia. The area is with numerous mega projects such as the African largest hydro-electric dam project (Great Ethiopian Renaissance Dam), agro-development projects, marble and other mining projects, and numerous water resource projects that such higher malaria problem needs intensive efforts on implementation and monitoring of successful control and prevention strategies. This result is slightly higher than an overall malaria assessment report of Benishangul Gumuz region health offices which is 57.5% [17]. The detected difference could be due to differences in study population, study season, microclimate, geo-meteorological settings, expansion of water resources and agro-development projects like dams, irrigation and massive agriculture-based projects. There is massive movement of migrant workers from the malaria free highlands to the area following construction of Great Ethiopian Renaissance Dam project and mega agricultural projects in the area[18] which could also be a variable for the highest malaria infection rate in the current study area.

The study indicates that males were more affected (57.71%) than females (42. 28%) with male: female ratio of 1.34:1. This finding agrees with other report in Benishangul Gumuz regional state in which rate of malaria parasite positive slides in male were 58.1% while that of females were 41.9%. Such higher malaria infection rate in males could be due to the fact that the area has enormous population movements of local migrants for daily labor activities who are majorly males. According to Hawaria *et al*., (2019)[19] and Tesfay *et al.,* (2018)[20], the socio-cultural practices in the area enforces males to involve in outdoor activities including sleeping outdoor for property safeguard which could have put them at greater risk of malaria infection compared to female.

Children age groups (<5 year) were the most infected (50.19%) compared to the other age groups. Therefore, malaria transmission in the area can be categorized under stable transmission. Children age groups are the most vulnerable to malaria infection because of their lowest immune response to malaria parasites compared to other groups.

The predominant malaria parasite in the study area was *P. falciparum,* 63.75% compared to *P. vivax,* 33.60%. Additionally, 2.64% mixed infection of *P. falciparum* and *P. vivax* was recorded from the current study site. This investigation is comparable to the overall national distribution of the *Plasmodium* species [4].

The study also indicated seasonal peaks in infection of malaria. The highest infection rate, 39.6% was recorded during spiring (September - November) followed by rainy season (June- August) with infection rate of 25.2%. This finding is in line with national and regional reports which indicates occurrence of severe malaria infections in months before and after long rainy seasons. In other hands, peak malaria transmission season (September to November) coincides with the major harvesting periods in the study area that it has serious consequences for national subsistence economy in general and in the study area in particular. This is in agreement with study conducted in different part of Ethiopia [20, 21].

In conclusion, the study confirmed that malaria is a leading public health problem in the study areas. This would be an imperative indicator that the areas need thoughtful attention and effective malaria interventions. The fatal *P. falciparum* found to be the predominant *Plasmodium* species. Children age of <5 years and males were found to be more malaria infected. In addition, malaria transmission in the area was found to be peaks during September to November, overlapping with the major agricultural products harvesting seasons. Therefore, malaria control strategy designers need to develop evidence-based interventions to reduce disease transmission and effectively eliminate malaria in northwestern Ethiopia which is with Mega development projects.

Conflict of interest

The author declares that he has no conflict of interest.

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