Five Year Trend Analysis of Malaria Cases in Adama, Boset and Lume Districts of East Shawa, Oromia, Ethiopia

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Research

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Abstract

Background

Malaria is an infectious disease caused by Plasmodium parasites. Of the five human malaria parasites Plasmodium falciparum and Plasmodium vivax are the two co-endemic predominant and widely distributed species in Ethiopia greatly affecting public health and socio-economic development. Even though enormous effort have been made countrywide to reduce the disease burden little has been reported about trends of malaria transmission in the several localities of malarious areas like East Shawa Zone of Oromia Regional State, Ethiopia. Thus, the present study was aimed at assessing five-year (2016-2020) trends of malaria transmission at Adama, Boset and Lume districts of East Shawa Zone of Oromia Regional State, Ethiopia.

Methods

Retrospective data were collected from the central surveillance of East Shawa Zone Health Office. The data collected was analyzed from September 2020 to December 2020 to examine trends of malaria epidemiology in three malarious districts in the Zone. The result shows, although a remarkable decrease in slide positivity rate (SPR) from (47.8 to 7.9%) and prevalence rate (6 to 1%) in the area, a recent slight increase of malaria SPR and prevalence was observed. Male individuals, particularly the productive section of the society (fifteen years and above age group) were more infected (60%), where falciparum, vivax and mixed malaria cases accounted for (53%), (41%), and (6%) respectively. Conclusion and Recommendations: Although reduction of malaria incidence was recorded in the study area, and higher malaria prevalence compared to the report of the national malaria indicator survey and inconsistency of the reduction rate noted in the study area demands due attention in the sector.

Introduction

Malaria is a mosquito-borne disease caused by *Plasmodium* parasites with a major public health problem in sub-Saharan Africa including Ethiopia. Still, it has been among the top ten ranking infectious diseases in Ethiopia despite significant progresses made in its intervention which geared toward elimination. According to WHO report released in December 2019, there were 228 million worldwide cases of malaria in 2018, compared to 231 million in 2017. Though the disease is declining globally, WHO African region continues to carry a disproportionately high share of the global malaria burden with more than 90% of malaria related morbidity and mortality (WHO, 2020).

Of the five species of *Plasmodium* parasites that cause human malaria, *Plasmodium falciparum* and *Plasmodium vivax* are by far the most predominant and widely distributed in Ethiopia accounting for 60% and 40% of malaria cases, respectively. The two species, namely: *P. falciparum* and *P. vivax* are exceptionally co-endemic in the country which also happens in other few African countries (Lo et al., 2017). The major mosquito vector known as *Anopheles arabiensis* (WHO, 2020) mainly transmits the parasite.

Ethiopia is one of the malaria epidemic prone countries in Africa where malaria is prevalent in over 75% of the country's land mass. Over 68% of the total population resides in the area below 2000 m altitude, which is considered to be at risk of malaria (Tadesse et al., 2018; Solomon et al., 2020). Due to the successful scale ups of the control interventions widespread malaria epidemics have not been largely reported in Ethiopia since 2003, except small scale outbreaks and seasonal case buildups (FMOH, 2020). However, malaria is remaining a major health problem in the country (Grum *et al.*, 2019). The major factors that limited, the national effort to combat against resurgence of malaria in Ethiopia are the challenges related to the effective implementation of the major intervention strategies for malaria control (early diagnosis, prompt treatment, selective vector control, and environmental management), together with resource intensive nature of the programs (Tadesse et al., 2018). Tadesse et al. (2018) added that malaria is the third leading cause of outpatient department (OPD) visits (36%) in the East Shawa Zone of Oromia Regional State.

Ethiopia has recently targeted malaria elimination nationwide in 2030, through intensifying the existing malaria control activities (FMOH, 2016a; Solomon et al., 2020). For the success of this strategic objective, analyzing the trends of malaria prevalence both at the national and local level is paramount to understand the dynamics of malaria transmission and the status of the effectiveness of malaria interventions targeted to curb the disease burden. Likewise, this study intended to examine the status of malaria cases in the study areas by analyzing five-year retrospective data from Adama, Boset, and Lume districts. These districts are located in East Shawa Zone surrounding Adama, the major town in the Great Rift Valley region of central Ethiopia. Due to warm temperature (16–32°C), rainfall patterns, and high humidity that is conducive for mosquito breeding this region is a malaria endemic area in central Ethiopia (Golassa *et al.*, 2017; File et al., 2019). Trend analysis of malaria prevalence is an input to plan for malaria control and prevention activities at local level to augment the national strategic plan of Ethiopia to eliminate malaria by 2030. The aim of this study is therefore, to assess the five-year trends of malaria burden and the pattern of its annual and inter-annual transmission over sex, age, and its seasonal dynamics in the study area.

Methods

Description of the study area

This study was conducted in three districts of East Shawa Zone administration of Oromia Regional State. The districts (Adama, Boset and Lume) were located surrounding Adama town, which is located at 8.54°N and 39.27°E, at about 99 km southeast of Addis Ababa. The surrounding districts were: Adama district, which includes the peri-urban, rural and smaller towns located around the Adama town administration. Lume district is located surrounding its own capital (Mojo town) found at the distance of 16 km northwest Adama town, and Boset district having its capital Olanchiti located at about 23 km northeast of Adama town. The areas are located within the Great Rift Valley region of central Ethiopia, having latitudinal location from 1436 -1850m above sea level (Fig. 1). Based on population projection of 2020 by Zone health office the districts were having the total population of 392,922. In addition to its latitudinal

location less than 2000m above sea level, rainfall pattern heavy rainfall during the summer season June to August, and a short rainy season around March, and suitable seasonal temperature (16-32°C) (Golassa *et al.*, 2017), and various human activities that favor mosquito breeding the location is malaria endemic area in central Ethiopia.

Study Design

A retrospective study was conducted to analyze five years (2016–2020) trends of malaria cases in Adama, Lume and Boset districts, East Shawa Zone, Oromia Regional State, Ethiopia. The source of the data was microscopically and/or RDTs confirmed malaria cases screened and reported by qualified medical laboratory technologies to central surveillance of malaria cases from all health facilities in each district and organized in zone health office. Expertise of Health Information Management System (HIMS) managed the database, which consists of monthly total malaria cases by age and sex. The data were accessed after approval of the ethical clearance protocol of this study from Adama Science and Technology University (ASTU), certificate reference number RECSOANS/BIO/01/2019 and consent of Oromia Regional State Health Bureau.

Data analysis

Retrospective data collected from the central surveillance the zone health office, were organized for analysis. The source data for the database was from the report of malaria microscopy/RDTs result of confirmed malaria cases by species performed by a laboratory technologist based on WHO protocol. The data collected from each district health facilities were organized and reported to zone health office central surveillance system. The data on the total population in the districts during the study, suspected malaria cases, people infected malaria was collected and checked for completeness and consistency and double entered into Microsoft excel version 16 for analysis. The excel data was transported to graphic and data analysis software (ORIGINPRO® version 9), to summarize and display the trends of malaria epidemiology in the area through table, bar graphs and line graphs.

Results

Annual trends of malaria burden

Out of 286,647 febrile suspected cases tested in the three districts, 47,016 (16.4%) were malaria positive, the prevalence ranged from 1–6%, in 2019 and 2016 respectively as detailed in (Table 1).

Table 1

Five-year annual trends of malaria cases in Adama, Boset and Lume districts of East Shawa Zone, Oromia, Ethiopia

Year	Total Population	Total Blood film examined	Total malaria positive cases	Slide Positivity rate (SPR) (%)	Prevalence rate (%)
2016	347,221	43,882	20,952	47.8	6.0
2017	357,295	58,105	9,989	17.2	2.7
2018	367,652	95,651	7,524	7.9	2.0
2019	378,314	43,879	4,119	9.4	1.0
2020	392,922	45,130	4,432	9.8	1.1

In addition, the slide positivity rate progressively lowered from 2016 to 2018, and slightly rose up in recent two years. On the other hand prevalence slightly dropped until 2019 (Table 1).

Similarly, the overall five year trends of malaria cases in the three districts was 47,016 with higher cases detected in Boset 21,641 (46%), followed by Adama 19,307 (41%), and Lume 6,068 (13%) districts (Fig. 2). The overall trends of malaria cases decreased from 2016 to 2018. However, slight increase in SPR was recorded in 2019 and 2020, and prevalence rate in 2020 (Fig. 3).

As reported elsewhere, due to suitable ecological factors in the region, malaria is endemic in the Great Rift Valley areas in central Ethiopia. The present study revealed temporal and spatial variation of malaria transmission in the three districts (Fig. 3). In addition to the general suitable climate in the region, various epidemiological factors exist that favor mosquito breeding contributing for transmission heterogeneity of malaria in those area. The presence of huge sugar cane farming and agricultural practiced around the Awash River might have contributed to higher malaria cases in Boset and Adama districts compared to that of Lume.

Trends of malaria parasite cases by age and sex groups

Though malaria parasite infected all age groups, the highest case was detected in those individuals from ≥ 15 years, which accounted for 60%, followed by $5 \leq 14$ age group with 28% cases, while children below the age of 5 are least affected (12%) (Fig. 4).

Out of the total confirmed malaria case by species in the study area (53%) were *Plasmodium falciparum*, (41%) *Plasmodium vivax*, and 6% were mixed infection.

Annual trends of malaria cases in different seasons of the year

The five-year retrospective study shows, malaria is occurring throughout the year in the study area. It shows seasonal (Fig. 5), inter annual, and spatial variations (Fig. 3). The major malaria peak season is in September and October, and the second minor peak was from May to June. The lowest malaria case was reported from January to March (Fig. 5).

Discussion

Retrospective analysis of malaria case is quite informative for the annual and inter-annual comparison of the disease burden among the different section of the society, so as to predict the future trend of the disease and the need to scale up effective interventions. The present study revealed that, malaria is still remaining a major public health problem in the study areas. Five-year trend analysis indicated higher malaria cases in Boset followed by Adama and Lume districts. Although the overall disease burden has decreased from 2016 to 2018, SPR and prevalence showed a slight increment in 2019 and 2020, respectively. During the study period, out of 286,647 symptomatic patients 47,016 (16.4%) were microscopically/RDTs confirmed malaria cases (Table 1). This finding is much greater than trend analysis study conducted in Wolkite; southwestern part of central Ethiopia (8.56%) (Solomon et al., 2020), and Tigray; northwestern of Ethiopia (6.96%) (Berhe et al., 2019), lower than similar study conducted in western part of Ethiopia; Guba district of Benishangul Gumuz Zone (51.04%) (Alkadir et al., 2020), also lower than the cross sectional study report from East Shawa Zone of Oromia Regional State in 2012 (25.2%) (Tadesse et al., 2018). Even though, the specific factors that accounted for such variation in malaria endemic regions need further investigation climatic factors and the status of malaria interventions in the region (Weiss et al., 2014; Berhane *et al.*, 2019) might have greatly contributed.

In the previous studies, it was reported that age-standardized malaria incidence and prevalence in Ethiopia between 1990 and 2015 showed a declining trend (Deribe *et al.*, 2017). However, in the present study maximum SPR was observed in 2016 (47.8%), and the minimum was in 2018 (7.9%). On the other hand, the prevalence also declined from 2016 to 2019, and slightly increased by 2020 (Fig. 2). Even though malaria prevalence has declined from (6 to 1%) in the study area, it is still higher when compared with the national malaria indicator survey conducted in 2007, 2011, and 2016 which ranged from (0.5 to 1.3%) (FMOH, 2016b). The reduction of SPR and prevalence was also not consistent in the study area. Although the major factors that contributed to such inconsistency in maintaining progressive decline of malaria incidence demand further investigation, the finding indicates the need for rigorous efforts to scale up the ongoing malaria control and prevention strategies in the region.

With respect to age, 60% of all malaria positive cases were individuals with ≥ 15 years of age, followed by $5 \leq 14$ age groups (28%), while children below the age of 5 were least affected. The higher malaria incidence rate was reported among group ≥ 15 years of age, which could largely be due to agricultural practices and other livelihood engagement of this productive section of the society in the study areas. Previous epidemiological studies from different localities of Ethiopia also reported more malaria cases among age group ≥ 15 years, followed by $5 \leq 14$ years (Chala and Petros, 2010; Gemechu *et al.*, 2015; Legesse et al., 2015; File et al., 2019; Berhe et al., 2019; Hassen and Dinka, 2020; Alkadir et al., 2020).

With regard to sex, comparatively more malaria cases (57.4%) were observed among males than female counterparts (Fig. 4). This finding is in agreement with trend analysis study reported from Sibu Sire district of East Wollega Zone in western part of Ethiopia (Gemechu *et al.*, 2015), southwestern of Ethiopia (Sena *et al.*, 2014), and south-central Ethiopia (Yimer *et al.*, 2015). This might be due to the work tradition in Ethiopian culture, where male individuals are commonly more responsible for outdoor activities than female. Since Anopheles mosquitoes generally bite more frequently outdoors than indoors (Kenea *et al.*, 2016), it might have contributed to such a higher malaria burden in male individuals.

Concerning malaria cases detected by species from the blood film, the present study revealed that out of 47,016 confirmed malaria cases 53%, 41% and 6% showed *P. falciparum*, *P. vivax* and mixed infection, respectively. The present study finding is in agreement with the previous reports (Tesfaye *et al.*, 2018; Berhe *et al.*, 2019; Alkadi *et al.*, 2020). The predominance of *P. falciparum* was consistent over the five years with slight seasonal variation. *P. vivax* cases during the minimal malaria season in the study area could be largely due to relapse.

Regarding seasonal transmission dynamics, year round malaria cases were observed in the three districts of the study areas. However, the highest peak was in the month of September and October (autumn), due to the formation of stagnant water and higher relative humidity suitable for mosquito breeding after the summer rainy season. This malaria peak season observed in the study areas is in agreement with similar studies conducted in different localities in Ethiopia (Hailemariam *et al.*, 2015; Legesse *et al.*, 2015; Tesfaye *et al.*, 2018). The second minor malaria season was during May to June (spring) following short rainy season in the country, which is in agreement with the report of Sena *et al.* (2014) and Gemechu *et al.* (2015).

Determinants of such seasonal variation of malaria transmission in the study sites might be due to variation in seasonal temperature, topographic features, the condition of the residential areas (availability bushy gorges, shanty dwelling, untidiness, etc.) (Alemu *et al.*, 2011; File *et al.*, 2019), also the economic factors of the inhabitant population are some of the common epidemiological factors for malaria incidence in the study area.

Conclusions And Recommendations

Despite lack of consistency in the reduction of malaria cases in the study area the present study revealed an abrupt reduction of the SPR from 47.8% in 2016 to 7.9% in 2018, and prevalence of 6% in 2016 to 1% in 2019 was observed. The reduction of SPR and prevalence was not consistent in the study area. In addition the prevalence malaria revealed in the study is higher compared to the report of the national malaria indicator survey, demanding due attention of the health sector authorities at regional, zonal and district levels. *Plasmodium falciparum* the deadliest malaria parasite is the most predominant (53%) species in the study areas. Generally, the productive section of the society with age of 15 years and above years was most affected, highly contributing malaria related morbidity and mortality, thus negatively affecting economic development. Therefore, health planners need to advance the present data

management and promote research to generate scientific evidence, and contribute to the effective implementation of the national malaria control and elimination plan.

Declarations

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Authors Contribution

TF has designed, collected and analyzed the data and wrote the paper, BC designed and, reviewed the paper. All authors read and approved the 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 East Shawa Health Office was maintained.

Consent for Publication

Applicable.

Competing interests

The authors declare that they have no competing interests.

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Figures

Figure 1

Figure 2

Five- year trends of malaria prevalence in Adama, Boset and Lume districts of East Shawa Zone, Oromia, Ethiopia

Figure 3

Five-year trends of malaria cases in Adama, Boset and Lume districts of East Shawa Zone, Oromia, Ethiopia

Figure 4

Yearly trends of confirmed malaria case proportion by age and sex from Adama, Boset and Lume districts, East Shawa Zone, Oromia, Ethiopia

Figure 5

Retrospective data summary showing monthly trends of malaria cases in Adama, Boset and Lume districts, East Shawa Zone, Oromia, Ethiopia.