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Trend and Associated Factors of Malaria Infection in Bahir Dar City þÿ A d m i n i s t r a t i o n , N o r t h w e s t E t h

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COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

TREND AND ASSOCIATED FACTORS OF MALARIA INFECTION IN BAHIR DAR CITY ADMINISTRATION, NORTHWEST ETHIOPIA: 2014–2020.

BY: YEROM GETAHUN (BSC IN PH)

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Candidates Declaration Form

Declaration

This is to certify that the thesis entitled "Trend and associated factors of malaria infection using 2014 -2020 report in Bahir Dar City administration, Northwest Ethiopia, 2021." submitted in partial fulfillment of the requirements for the degree of Master of public health. Department of Health Service Management, Bahir Dar University, is a record of original work carried out by me and has never been submitted to this or any other institution to get any other degree or certificates. The assistance and help I received during the course of this investigation have been duly acknowledged.

Name of the candidate	Date	Place

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Approval of thesis for defense

I hereby certify that I have supervised, read, and evaluated this thesis titled "Trend and associated factors of malaria infection using 2014 -2020 report in Bahir Dar City administration, Northwest Ethiopia, 2021." by Yerom Getahun (B.SC In PH) prepared under my guidance. I recommend the thesis be submitted for final oral defense.

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Abstract

Background: Despite ranges of anti-malaria interventions worldwide, it lasts one of the top public health problems causing morbidity, mortality and high cost for care. It has varying magnitude across countries and has highest burden in developing countries including Ethiopia. Having updated evidence on the status of malaria distribution, trends and its associated factor is important to take evidence based anti-malaria interventions.

Objective: The objective of this study was to assess the trend and associated factors of malaria infection in Bahir Dar City administration, Northwest Ethiopia.

Method: A retrospective study was conducted on seven years' (2014-2020) zonal data. To determine factors associated with malaria infection, malaria records of 2020 were collected from randomly selected laboratory logbook of health facilities. Data were exported from excel sheet to SPSS version 20 software for cleaning and analysis. Descriptive statics such as overall malaria prevalence, and trend of malaria by age, sex, year and seasons were computed. Multivariable logistic regression analysis was used to identify factors associated with malaria infection. The strength of association was described using odds ratio at 95% of CI and p-value less than 0.05.

Result: A total of 436,591 patients were tested for malaria at Bahir Dar city administration from 2014 to 2020. And 44,855 were reported as malaria cases and 43,415 (97%) of them were reported as confirmed malaria cases with the rest 1440 (3%) were clinical cases. The overall malaria infection in the present study showed a fluctuating trend with a decreasing order from 2014 to 2018 and increasing sharply for the last two years 2019 to 2020. Plasmodium falciparum and plasmodium vivax accounted for 30044(69 %) and 12648(29%) and the rest clinical, respectively. Age, area of residence and season of the year were statically significant with malaria infection at P-value < 0.05.

Conclusion and recommendations: Malaria is still a public health burden in the study area which characterized by progressive decline for 5 years and sudden increase in the last 2 years Therefore it needs further investigation like community- based assessment to determine possible contributing factors and interventions according to malaria prevention and control strategies.

Key Words: *Malaria, trend, Prevalence, seasonal distribution, Bahir Dar, Ethiopia*

List of acronyms

AOR Adjusted Odds Ratio

BF Blood film

DHS Demographic and health survey

EC Ethiopian calendar

HF Health facility

HIT Health information technician

ICAP International Center for Aids care and Treatment Program

ITN Insecticide-treated mosquito nets

LLIN Long-lasting insecticidal nets

MDTA Malaria diagnosis and treatment activities

NGO Nongovernmental organization

PF Plasmodium Falciparum

PMI Presidential Malaria Initiative

PV Plasmodium Vivax

RDT Rapid diagnostic test

SPSS Statistical Package for Social Sciences

TPR Test positivity rate

WHO World Health Organization

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1. Introduction

1.1 Background

Malaria is an infectious disease caused by protozoan parasites from the Plasmodium family that can be transmitted by the bite of the female Anopheles mosquito or by a contaminated needle or blood transfusion (1). Among Plasmodium species that infect various species of vertebrates, five are known to infect humans, namely, Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae, and Plasmodium knowlesi (2, 3). Microscopic diagnosis and Rapid diagnostic test are the methods employed for confirmation of malaria etiology(4). Malaria is one of the major public health problems worldwide with plasmodium falciparum is the deadliest type of the disease-causing organism (5). *Plasmodium falciparum* is the most prevalent malaria parasite in sub-Saharan Africa, accounting for 99% of estimated malaria cases in 2016. Outside of Africa, *P. vivax* is the predominant parasite in the WHO Region of the Americas, representing 64% of malaria cases, and is above 30% in the WHO Southeast Asia and 40% in the Eastern Mediterranean regions (6).

Malaria is still among the major public health problems in Ethiopia also (6). In Ethiopia, malaria is highly seasonal, unstable with epidemic-prone transmission pattern in many parts of the country. Plasmodium falciparum (70 percent) and P. vivax (30 percent) are the major malaria parasites. Anopheles arabinose is the primary malaria vector in Ethiopia, with An. funestus, An. pharoensis, and An. nili as secondary vectors. Peak malaria transmission occurs between September and December, after the main rainy season from June to August. In addition, some areas experience a second minor malaria transmission period from April to June, following a short rainy season from February to March. Since peak malaria transmission often coincides with the planting and harvesting season, the majority of malaria burden is among older children and working adults in rural agricultural areas, thus there is a resultant heavy economic burden in Ethiopia. And also historically Ethiopia has been prone to periodic widespread malaria epidemics (7-9).

The trend of malaria in south western Ethiopia was reported to be increased from 76% in 2015 to 90% in 2018 (10) but in southern central Ethiopia the annual incidence rate was reported to be reduced from 157 in 2015 to 35 in 2018 (11) and its transmission in southern Ethiopia was strongly affected by seasonal variation (12)

Trend of malaria over the years is either stagnant or still in increment (13). Increased larval abundances of mosquitos are directly related with reservoir water level and wetted shoreline area (14)

Since malaria is an illness which complicates to severe disease and death; WHO *Global technical strategy for malaria 2016–2030*, which sets out a vision for accelerating progress towards malaria elimination; by ensuring universal access to malaria prevention, diagnosis and treatment, accelerating efforts towards elimination and attainment of malaria free status and transform malaria surveillance into a core intervention (15).

Vector control is a cornerstone of malaria control and it remains the most generally elective measure to prevent malaria transmission and therefore is one of the strategic approaches to malaria control. Interventions using vector control methods are; environmental management, Larviciding Insecticide-treated mosquito nets, improved housing, Repellents and mosquito coils, Indoor residual spraying (4).

Accurate diagnosis and prompt treatment of malaria cases are essential interventions in treatment of P. vivax. Radical cure with primaquine is recommended for patients with P. vivax. A single-dose primaquine is for the treatment of P. falciparum gametocytes. AL is used for mixed infections due to both P. falciparum and P. vivax. At a health post, children less than 6 years of age with severe malaria are given rectal artesunate as pre-referral treatment (10). The study area which is surrounded by Lake Tana and Abay River is high risk malaria area all the year time. The geographical area of Bahir Dar city administration served by health facilities

Malaria case: Occurrence of malaria illness/disease in a person diagnosed with parasitological testing or clinically and Confirmed case: Detected or specifically identified malaria parasite species by microscopy on blood films in a laboratory /RDT with appropriate expertise while Suspected case are patients suspected by a health worker to be ill due to malaria, generally on the basis of the presence of fever with or without other symptoms.

Catchment area: The geographical area of an organization served by its facilities, Diagnosis: Identification of a Malaria case by systematic analysis of the back ground or history, examination of the signs and symptoms. Trend of Malaria: is long term change in malaria case through time Seasonal variation: Changes of malaria case based on four seasons in the year

1.2 Statement of the problem

Globally, an estimated 3.3 billion people are at risk of getting malaria where 1.2 billion are at high risk(16). In 2013, there were also an estimated 198 million cases of malaria (uncertainty range: 124–283 million) and 584 000 malaria deaths globally (range: 367 000–755 000) (4). According to World Health Organization 2018 report 93% of malaria case were occurred in Africa region followed by the WHO South-East Asia Region with 3.4% of the cases and the WHO Eastern Mediterranean Region with 2.1% (17).

WHO report from 2015 to 2018 stated that there is no significant reduction in malaria incidence and few countries were on track to reduce incidence by 2020, where malaria is still endemic but with no accelerated change in minimizing mortality and morbidity globally (18)

Currently, due to the high burden of malaria parallel to the COVID-19, the WHO is calling on countries to maintain core malaria control services. It is because of the effect of COVID-19 on malaria control activities that makes the health facilities less effective in malaria control and also prevents people from visiting healthcare facilities for malaria(18). The UNICEF at the world malaria day of 2020 showed that <5 years' children accounted for 67% deaths due to malaria worldwide in 2018 and a child died every 2 minutes from malaria (19). Many sub Saharan African countries accounted for above 90% of global malaria cases and deaths due to less access to healthcare facilities, favorable climatic conditions and high population mobility to high risk areas (20).

The world malaria report showed that the regional and global trends in malaria burden as; In 2018, an estimated 228 million cases of malaria occurred worldwide, compared with 251 million cases in 2010 and 231 million cases in 2017. And 405 000 deaths from malaria globally in 2018, compared with 416 000 estimated deaths in 2017, and 585 000 in 2010 (18).

Most malaria cases 2018 were in WHO African region 213 million (93%). The incidence of malaria declines globally between 2010 and 2018 from 71 to 57 cases per 1000 population at risk. However, from 2014 to 2018 the rate of change slowed dramatically or reducing to 57 in 2014 remains similar through 2018. Plasmodium falciparum is most prevalent species in WHO African region (99.7%) (18).

Despite various anti-malaria interventions, malaria is one of the major public health problems in Ethiopia. The study conducted at Woreta health center (South Gondar) showed that the five-year trend of malaria prevalence in each year ranged from 4.1% to 6.7% and overall prevalence of malaria was 5.4% (95%CI: 4.9%-5.9%) (21). Similarly, a study from Dembia catchment health facilities (North Gondar) showed that the prevalence of malaria was highly variable across years ranging from 14% to 30.2%. The highest prevalence was observed in 2016 (30.2%) followed by 2015 (24%). Of the twelve months of the seven years, October had the highest prevalence (32.6%) followed by September (27.2%). On the other hand, the least prevalence was observed in February (15.1%). The highest prevalence was observed during autumn (September to November) (27.9%), followed by 23.3 and 18.4% in summer (June to August) and winter (December to February), respectively. Spring (March to May) was the season with the least prevalence (17.8%) (22).

Except one article before 6 years in Felegehiwot referral hospital which documented trend of malaria prevalence from 2010-2014 G.C, there is no malaria study in Bahir Dar city (23). Bahir Dar City is a place highly viable for malaria transmission due to the availability of water bodies and stagnant water throughout the year. Thus, this study aimed to investigate trends and seasonal variations of malaria prevalence using seven years' malaria records from health facilities in Bahir Dar city administration, northwest Ethiopia.

1.3 Significance of the study

Even if the malaria prevention, control and treatment services decentralized to primary health care units and health posts, the magnitude remained high in different countries as well as in different regions and districts of Ethiopia. This might be more serious in the current situation of COVID-19 pandemic that hinders the activities of healthcare facilities and malaria control offices as well as the healthcare seeking practices of the community.

Generating long time evidence including the current situation (trend and seasonal variation) are crucial in malaria control activities by improving evidence-based decision making and targeted intervention. Knowing the seasonal burdens is also important to take action accordingly. All these are vital in areas that are at the highest risk of malaria incidence such as Bahir Dar City. Therefore, investigating the trend and seasonal variations of malaria cases in Bahir Dar City administration is important to enhance malaria prevention and control activities.

Bahir Dar city administration zonal health department, health facilities, regional health bureau and APHI are the primary beneficiaries from the results of this study. It will enable them to know the magnitude, trend and seasonal variations of malaria so that they can do evidence based antimalarial interventions. Moreover, it will also be important literature to researchers in malaria prevention and control to investigate further in the field.

2. Literature review

2.1 Review on trend of malaria infection

The number of malaria cases globally fell from an estimated 262 million in 2000 to 214 million in 2015 a decline of 18%. Most cases in 2015 are estimated to have occurred in the WHO African Region (88%), followed by the WHO South-East Asia Region (10%) and the WHO Eastern Mediterranean Region (2%) (24). Different studies have documented the trend of malaria transmission in different parts of the world. It was documented that the trend of malaria transmission is either stagnant or rapidly rising (8, 15). Here after the literature review was discussed briefly.

According to 7 years' trends study from 2011 to 2016 on malaria prevalence in China the incidence of malaria is rising upward. *Plasmodium vivax (*90.8%) was the most common type of malaria that affected the region where *Plasmodium falciparum* accounts for only 7.8% of cases. It was reported that history of malaria, adult males, children under the age of 15, being farmers, soldier, and student, were at higher risks of clinical. The seasonal malaria index reached its highest level (2.95) in June (25).

According to 16 years (2000-2016) surveillance-based report in South America about 51.4% of totally screened had experienced malaria. It had determined high prevalence of malaria which was in increasing manner for the first five years (2000-2005) and then the trend was gradually declining with a steep decline from 2005 to 2011 and pronounced decline then after. From 2000 to 2006 *Plasmodium falciparum* was common and in 2007 *P. vivax* was the predominant species (26).

As indicated on the study conducted in Kenya 10 years (2004-2014) time series analysis of trend of malaria had shown that variations in rain fail and maximum temperature were the main factor that affected prevalence of malaria (27).

In 2016, there were an estimated 2,927,266 new malaria cases in Ethiopia. Despite the population at risk were increased from 59,637,819 to 69,634,176 between 2010 and 2016, the number of cases declined by 60%. In the same year, malaria caused an estimated 4,782 deaths. Malaria related mortality in Ethiopia have contributed for 2.8% of infectious and parasitic disease mortality and 0.7% of all deaths by the year 2016. Similarly, malaria mortality in

Ethiopia has contributed for 1.2% of malaria related mortality in Africa and 1.07% of global malaria mortality. Mortality due to malaria was highest among males and under five children. Of the 4,782 malaria related mortalities and more than 2,400 deaths were among males (7).

2.2 Review Seasonal variation and factors associated with malaria infection

The Study conducted in Lower Moshi (Tanganik) stated that the risk of testing positive for malaria were significantly highest among individuals aged between 6 and 15 years (OR = 1.65; 1.65 CI = 1.28–2.13; $p = 0.001$) and 16–30 years (OR = 1.49; CI = 1.17–1.89; $p = 0.001$) and when adjusted for age, the risk were significantly higher among male individuals when compared to female individuals (OR = 1.54; 1.00–1.31; $p = 0.044$) (38).

The study conducted in Ethiopia on the pooled prevalence of malaria among adults in Ethiopia was 13.61% (95% CI: 8.70–18.53). Subgroup analysis based on types of malaria cases showed that the prevalence of malaria among symptomatic and asymptomatic adults was 15.34% and 11.99%, respectively (37).

In southern Ethiopia, in Halaba special district, the highest prevalence of malaria reach the peak from the month September to the December (33). Another study conducted at Wolega zone in one year shows that total of 125917 suspected malaria cases examined from all districts and 21,2% confirmed malaria cases were reported. Age group of $\geq$ 15 years 60% were more affected. The highest peak of malaria cases was reported during autumn season followed by spring (34).

Other study conducted at Aderkay found those Over 17 years, 20,483 blood films were requested for malaria diagnosis at the health center. Out of this, 36.1% were microscopically confirmed malaria cases. *Plasmodium falciparum, Plasmodium vivax,* and their mixed infection accounted for 68.85, 28.79, and 2.34% of all malaria cases, respectively. There was a remarkable reduction of overall malaria during the 17 years. Malaria was reported in all age groups of both sexes, but its positivity rate was significantly higher in males and in the 15–24 years than their counterparts (31).

Another study conducted at Assosa found the four years' period, the Annual parasitic index (API) of malaria was decreased from 341 to 125 per 1000 population. Clinical malaria treatment rate was decreased from 19% in 2013/2014 to 2.70% n2016/2017.The four years' proportion of

plasmodium falciparum and Vivax were 91 & 9 respectively**.** The incidence of both malaria inpatients and malaria case fatality rate were increase with inconsistent trend, both were decreased from July 2013-june 2016 and both were increased from July 2016- June 2017(32).

The study conducted at Guba district shows that a total of 16,964 malaria suspects were diagnosed using microscopy over the last 5 years, of which 8658 (51.04%) were confirmed positive cases. *PF*, *PV*, and mixed infection (both species) accounted for 75.2, 24.5 and 0.28% of the cases, respectively. Males patients were more affected ($n = 5028$, 58.1%) than female ones ($n = 3630$, 41.9%). Of the total confirmed cases, 60.4% were age group of subjects (≥ 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 (36).

As study conducted at selected zones in Amhara region for 5 years, a total of 2,827,722 cases have been received a diagnostic test of; Microscopy 60.56% and Rapid Diagnostic Test (RDT) 39.44%. Trends of total patients treated as confirmed and clinical malaria cases in July 2017–June 2018 were decreased to 14% as compared from July 2015–June 2015, 25%. From total cases received diagnostic tests only 36% were confirmed and clinical cases treated with antimalarial. Of this Plasmodium falciparum and vivax malaria cases were confirmed to be 1002,946 99, 96% and clinical malaria cases were 0.04%, respectively (28).

Other study conducted at Raya Azebo shows a total of 29,930 malaria cases were reported from 2011 to 2016. Of these, 23,018 were confirmed cases while, 6912 were reported as clinical cases. *PF* (56.9%) was the most dominated species. Malaria was reported in all age group and both sexes with highest in male and > 15 age categories. The highest peak malaria distribution was occurred in spring season. The overall trends of malaria case were increased in the past 6 years (2011–2016) with exception slightly decreased from 2012 to 2013 (35).

According to research conducted at Kombolcha Health Centre from 2009 to 2016 malaria was confirmed and reported in 7.52% of the examined blood films with 258 mean annual cases, Minimum and maximum cases were reported in 2009 and 2010, respectively. Plasmodium falciparum and P. vivax accounted 60.2% and 35.5% of the cases, respectively. Male patients were more affected (68.1%) than female ones (31.89%). The highest malaria prevalence

(69.69%) was seen in the 15–45 years' age group, followed by those 5–14 years old (14.67%), and finally patients under five years old (10.5%). Malaria cases were at a peak in spring and reduced in the winter season (29).

As study conducted at Ataye District Hospital from 2013 to 2017 of the examined blood films, 8.4% were microscopically confirmed malaria cases. The trend of malaria prevalence in the present study seems non- fluctuating. *Plasmodium falciparum* and *Plasmodium vivax* accounted for 78.2% and 20.9% cases, respectively. From total positive cases, 1.0% of cases were mixed *P. falciparum*/*P. vivax* infections, and that no *Plasmodium malarae* and *Plasmodium oval* infections were found by malaria microscopists. Malaria cases were higher in males than females. With regard to age groups, higher numbers of malaria cases were observed in age group 15–45 years old. Malaria cases were high in spring (September to December), which is a peak malaria transmission period in Ethiopia (30)

As study conducted in Woreta health center; malaria remains a major public health challenge. Hence, interventions to decrease the impact of the disease have to be evaluated and strengthened, the prevalence of malaria in each year ranged from 4.1% to 6.7%. The overall prevalence of malaria was 5.4%. The two most important species of malaria parasite identified were P. falciparum 53.7%, P. vivax 42.4% and the res Mixed. Relatively higher proportions of cases were documented in the months of November, December and June which was 11.1%, 8.1% and 7.2%, respectively. Patients who visited the health center in the month of December were >4 times more likely to be infected as compared with those who came to the health center in September. Females were 1.3 times more likely to be infected than males. Similarly, patients in the age group above 15 were 1.9 times more likely to be infected than individuals < 5 years old (22).

According to study conducted in Felegehiwot referral hospital; from 2010-2014 five-year trend total of 14,750 blood films were diagnosed for malaria. Mixed infection was observed from September to October, in April and from June through August. Maximum cases were observed in 2012 where as the least were observed in 2010. From 2011 to 2012, there was a sharp increment in P. vivax than P. falciparum infections. However, from 2012 through 2014, fast decrement in P. vivax than P. falciparum infections were observed. Finally, from 2011 to 2012, there was increment in mixed infections (16).

3. Conceptual framework

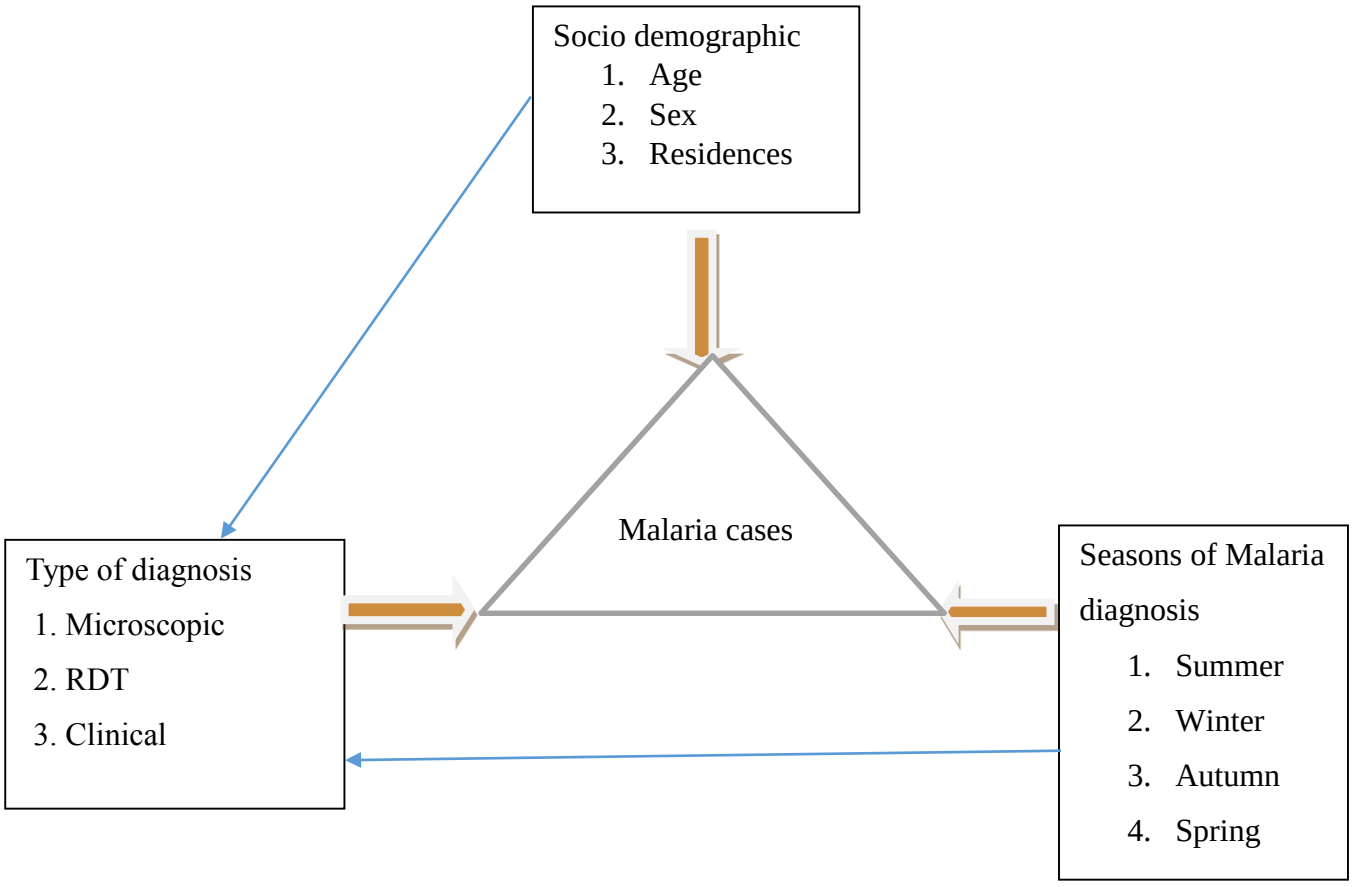

Figure 1: Conceptual framework of study variables

4. Objective of the study

4.1 General objective

To assess the trend and associated factors of malaria infection using 2014 -2020 report in Bahir Dar City administration, Northwest Ethiopia, 2021

4.2 Specific Objective

- To determine trend of malaria infection using 2014-2020 malaria report in Bahir Dar City administration, Northwest Ethiopia, 2021
- To describe the seasonal distribution of malaria infection using 2014-2020 malaria report in Bahir Dar City administration, Northwest Ethiopia, 2021
- To identify factors associated with malaria infection using 2020 malaria records in Bahir Dar City administration, Northwest Ethiopia, 2021

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5. Methods

5.1. Study design and period

Retrospective study was conducted on the seven years' (2014-2020) zonal data base to describe the seasonal distribution and trend of malaria between October 2020 to March 2021. To determine associated factors for prevalence of malaria, a 2020 facility level data were collected from laboratory logbooks of selected facilities.

5.2 Study area and settings

This study was carried out in Bahir Dar city administration North west Ethiopia. The City Administration is found in the Southern shore of Lake Tana, the source of the Blue Nile in Amhara National Regional State and located approximately 565 km Northwest of Addis Ababa, having an elevation of 1840 meters above sea level, based on Ethiopia ministry of finance 2012 E.C report, Bahir Dar City Administration has also total population of 389,177, of whom 194,199 are males and 194,978 females.

The city administration has one special zonal health department which is one of 13 administrative zones in Amhara region and governs 13 governmental and 40 non-governmental health facilities under its catchment area, of those 20 facilities including satellite or rural health facilities (Tisabay, Zenzelma, Zegie and Meshenty) health centers from the surrounding areas which reports essential health services including malaria as its data shows. The Public health emergency management (PHEM) is responsible in data collection on weekly bases, periodic surveillance and evidence based vector control intervention in collaboration with responsible stakeholders including global fund and ICAP. It also manages and maintains data base of reported data.

5.3 **Source and study population**

5.3.1 **Source population;** The source populations were all malaria tests recorded and reported to Bahir Dar city administration during the past 7 years (2014-2020).

5.3.2 Study population; The study populations were all malaria cases recorded and reported to Bahir Dar city administration during the past 7 years (2014-2020).

5.4 Inclusion and exclusion criteria

5.4.1 Inclusion criteria

- All malaria tested and recorded during 2014 -2020 were included in the study.

5.4.2 **Exclusion criteria**

- Malaria tests recorded with incomplete data elements were excluded from the study.

5.5 Study Variables

5.5.1. Dependent variable

The dependent variable of the study:

- Malaria infection.

5.5.2. Independent Variables

The independent variables will include:

- Socio demographic variables: age, sex, residence
- Type of malaria diagnosis: BF, RDT
- Time of diagnosis: month and seasons

5.6. Sample size determination

For characterizing trend of malaria, all malaria related records in the data-base based on reports from catchment health facilities of Bahir Dar city administration health department from 2014-2020 were included in the study.

To identify associated factors of malaria infection, sample size was determined from the recent one-year (2020) malaria tests recorded in laboratory logbook in health facilities. The reason for taking 2020 malaria cases was due to the sharp increase of malaria cases in 2020 and need to see factors that contributed to the increment of malaria cases. The sample size was calculated using single population proportion formula using assumption of 50% malaria prevalence to increase precision, 95% confidence level (Za/2) = ±1.96, 5% margin of error (d), and 10% nonresponse rate.

$n= (Za/2)^2 * P (1-P)/ (d)^2$

$= (1.96)^2 * .5(1-.5)/ (.05)^2$

$= 3.84*0.25/0.0025$

$= 384$

To consider variation in health facilities, the design effect of 2 was used. The minimum sample size calculated was multiplied by 2 and 10% non-response rate. Thus, overall sample of 845 was used for determining associated factors for malaria during 2020.

5.7. Sampling technique

All malaria test report from 2014 to 2020 was collected from zonal health department weekly report of PHEM and disease report for trend by using designed check list.

A multistage sampling technique was used to select health facilities for 2020 malaria records to identify factors associated with malaria infection. First, we stratified 20 health facilities in to urban (16 Health facility) and rural (4 health facility). Secondly, we further stratified health facilities as Hospital, health centers and clinic. Thirdly, we selected 20% of health facilities randomly from each stratum due to time and resource constraints. Accordingly, we included Addisalem hospital, Dagmawi Minilik Health center, and Eyasta clinic) from Urban, and Tisa bay health Center from rural settings lottery method. The required sample size was calculated and allocated to each facility by their proportion of one-year data tested for malaria. Finally, systematic random sampling was used to select malaria cases from laboratory registration logbooks. After the first patient drown from the first 36 patients by lottery method, every 36 (K) patients were selected until attaining the required sample size (Fig 2:)

Table 1: proportional allocation of sample sizes for selected health facilities among 845 sample sizes

s.no	Health facility	Total tests	Proportion	Sample size
1	Addisalem Hospital	8269	0.271006	229
2	Dagmawi Minilik health center	4203	0.137278	116
3	Tis Abay Health center	15328	0.502959	425
4	Eyasta Clinic	2659	0.086391	75
	Total	30459	1.00	845

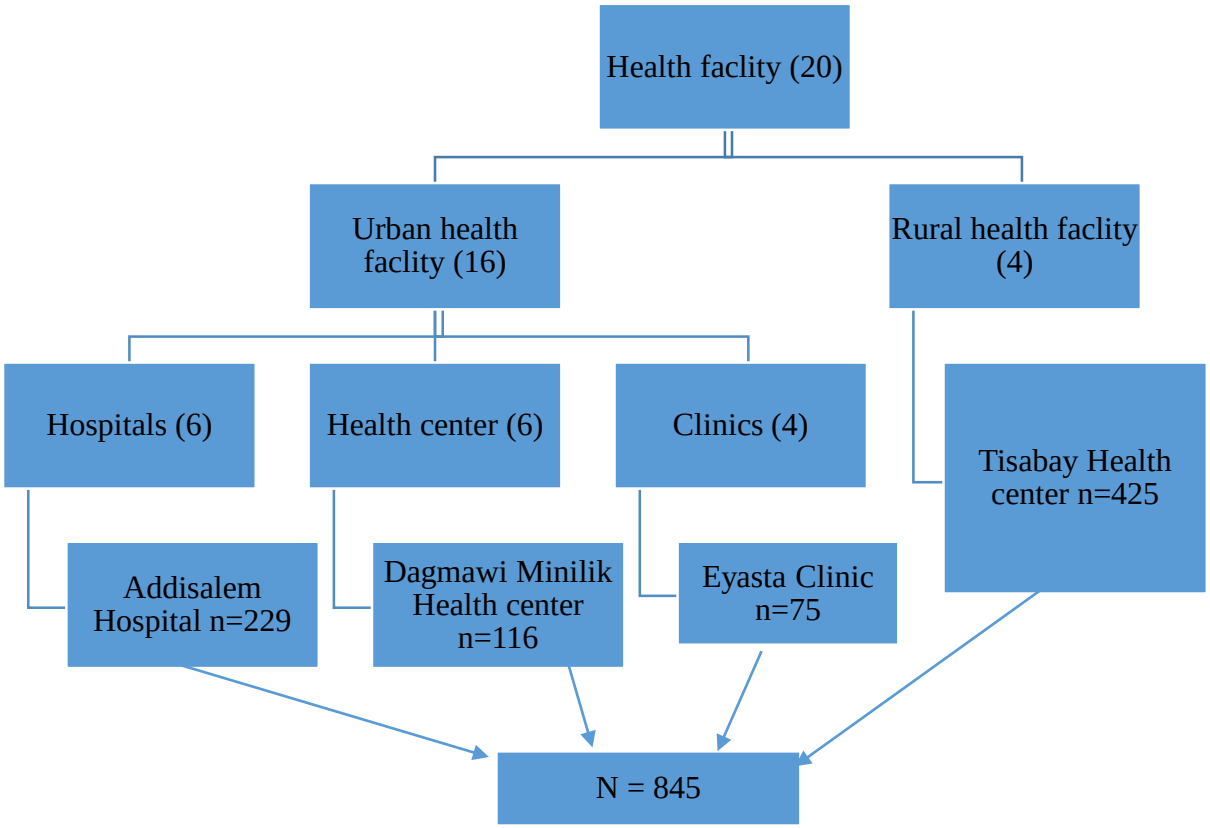


Figure 2: Diagrammatic sketch of sampling procedure in Bahir Dar city administration 2020

5.8. Data collection instrument

Data extraction form was prepared to extract data based on the reporting format and it consists of demographic variables, total test, number of confirmed tests, Month/season of reporting, species of malaria and type of diagnosis used were major contents of data collection check list. In similar way, data extraction check list was prepared to collect data from health facilities and pretested before the actual data collection. Sociodemographic variables, name of health facility, month of test, diagnostic test, test result, residence, and type of species were major contents of a check list.

5.9 Data collection procedures

Prior to data collection, data collectors were recruited and trained on how to collect data. Bahir Dar City administration health department and respective health facilities were communicated by written letter for permission. Then data collectors (trained health information technicians (HIT)) extracted the weekly and aggregated data from the data base using data extraction check list. Seven years' malaria data from July 2014 to Jun 2020 were collected.

Prior to collecting data from health facility, the total number of tests was identified and K was calculated for each facility. Then based on K, the data were collected from the logbook by using checklists. Data collectors were supervised closely to assure data quality and completeness. Since the data needs multiple filtrations and aggregation crosschecking was done with source document to determine trend, and similar procedure conducted for associated factor from recent one year 2020 laboratory register malaria tested data for randomly selected health facilities.

5.10 Data quality control

To ensure quality of data, training was given to data collectors. A supportive supervision was given by the Principal investigator (PI). Data extraction format was Pre-tested in health facilities and health departments other than the study area but with similar situations. Clarity of words and order of questions were modified after a pretest of the questionnaire.

5.11 Statistical analysis

Data were first aggregated by different categories using Excel spreadsheet and summarized to different specific elements like summarizing aggregated data by months, seasons, year's species, type of diagnosis, sex and age groups to determine trend. Excel data were exported to SPSS version 20 for cleaning and analysis. Various descriptive statistical analyses, such as proportions, trends by year, season, and malaria species, and seasonal distribution of malaria were computed. Multivariable binary logistic regression analysis was used to identify factors associated with malaria infection. Strength of associations was described using 95%CI and statistical significance was determined at p-value less than 0.05. Study findings are presented using text, tables, and figures.

5.12 Ethical consideration

The ethical clearance was taken from Bahir Dar University, College of Medicine and Health Sciences ethical review board. The permission letter was taken from Amhara Public Health Institute, zonal health department and selected health facilities. Data confidentiality and privacy was kept through anonymity were and removing personal identifiers from data sets.

5.13 Dissemination of the results

The findings of this study will be presented and submitted to School of Public health. It will be submitted to Bahir Dar City administration zonal health department, APHI and regional health bureau. It will also present at research conferences, seminars and submitted for publication at the peer reviewed journals for publication.

6. Result

6.1 Characteristics of seven years malaria data

During the last 7- years, there were about 3, 412, 001 OPD visits in health facilities of Bahir Dar city administration. A total of 43 6,591 patients were tested for malaria and 44,855 (10%) were reported as malaria cases, (43,415 (97%) of them were reported as confirmed malaria cases with the rest 1440 (3%) were clinical cases. In 2020, higher number of malaria suspected cases (n=88221) were examined and 14,778 (16.7%) of them were confirmed malaria cases, whereas in 2018 the lowest number of suspected case, n= 46, 049 were examined and 1425 (3%) of them were confirmed malaria case reported. Regarding to clinical malaria cases, there were highest number 299 (10%) from 2862 malaria cases reported in 2017 and no clinical case reported during 2019 and 2020. Among total malaria cases 26931(58%) were males and above15 years accounted the highest number 26, 999(60%) followed by 5-14 years 10,021(22%) (Table 2)

Table 2: Characteristics of Malaria cases among tested during the last 7 years in Bahir Dar City Administration (2014-2020), Northwest Ethiopia, 2021

		Malaria case			Malaria case by Sex		Malaria casein age groups		
	Tested for Malaria	Total malaria case	Confirmed malaria	Clinical malaria case	Male	Female	Less than 5 years	5--14 years	Greater and equal 15 years
Year	N	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
2014	55517	8394 (15)	8054 (96)	340 (4)	4904 (58)	3490 (42)	2338 (28)	2488 (30)	3568 (42)
2015	62187	7033 (11)	6470 (92)	563 (8)	4460 (63)	2573 (37)	1095 (16)	974 (14)	4964 970)
2016	63458	4666 (7.4)	4471 (96)	195 (4)	2333 (61)	1833 (39)	873 (19)	805 (17)	2988 (64)
2017	65345	2862 (4.4)	2563 (90)	299 (10)	1893 (66)	969 (34)	455 (16)	477 (17)	1930 (67)
2018	46049	1425 (3)	1382 (97)	43 (3)	984 (69)	441 (31)	173 (12)	259 (18)	993 (70)
2019	55814	5697 (10)	5697 (100)	0 (0)	3410 (60)	2287 (40)	760 (13)	1352 (24)	3585 (63)
2020	88221	14778 (16.7)	14778 (100)	0 (0)	8447 (57)	6331 (42)	2141 (15)	3666 (25)	8971 (60)
Total	436591	44855 (10.3)	43415 (97)	1440 (3)	26931 (60)	17924 (40)	7835 (17)	10021 (22)	26999 (60)

In the study area malaria cases were identified by using confirmatory tests of RDT and /or BF microscopy in which most cases, 414766(95%), were confirmed with BF microscopy and 21825 (5%) by RDT during the last 7 years, and plasmodium falciparum (Pf) was mostly isolated malaria parasite 30044(69%) followed by plasmodium vivax (Pv) 12648(29%) and mixed 723(2%). The proportions of test types and specious of malaria were relatively similar in the entire years of study period (Table 3).

Table 3: Malaria diagnosis test type and /specious distribution during the last 7 years in Bahir Dar City Administration (2014-2020), Northwest Ethiopia, 2021

Years	Total Tested for Malaria	Type of tests		Specious among confirmed			
		BF	RDT	Malaria confirmed	Pf	PV	Mixed
	n	n (%)	n (%)	N	n (%)	n (%)	n (%)
2014	55517	52500 (95)	3017 (5)	8054	5420 (67)	2475 (31)	159 (2)
2015	62187	58773 (95)	3414 (5)	6470	4643 (71)	1715 (27)	112 (1.7)
2016	63458	61282 (97)	2176 (3)	4471	3062 (68)	1338 (30)	71 (1.5)
2017	65345	63181 (97)	2164 (3)	2563	1598 (63)	920 (36)	45 (1.7)
2018	46049	45339 (98)	710 (2)	1382	905 (65)	462 (33)	15 (1)
2019	55814	53676 (96)	2138 (4)	5697	4294 (75)	1365 (24)	38 (0.6)
2020	88221	80015 (91)	8206 (9)	14778	10122 (68)	4373 (30)	283 (2)
Total	436591	414766 (95)	21825 (5)	43415	30044 (69)	12648 (29)	723(1.6)

6.2 Trend of malaria cases during last 7 years in Bahir Dar city administration (2014-2020).

The overall trend of malaria cases in the present study showed fluctuating with a decreasing order from 2014 to 2018 and Sharp increasing since 2019-2020. The annual trend of malaria cases was 15%, 11%, 7%, 4%, 3%, 10% and 17% in 2014, 2015, 2016, 2017, 2018, 2019 and 2020, respectively (Figure 3).

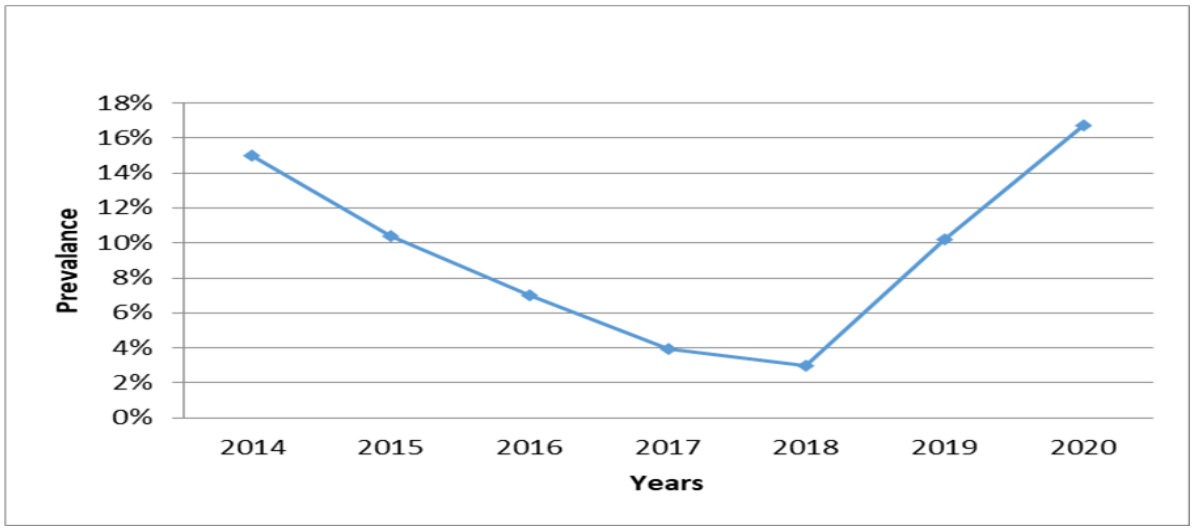
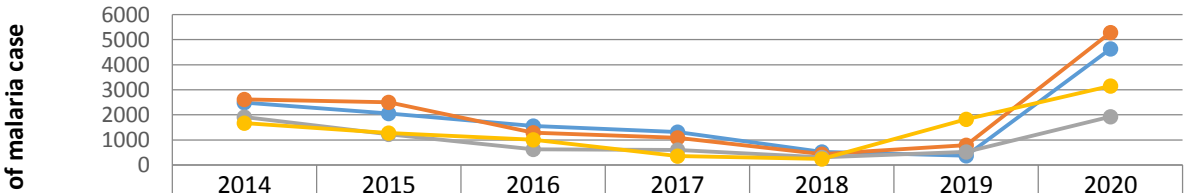


Figure 3: Annual trend of malaria during the last 7 years in Bahir Dar city administration (2014-2020)

Despite the apparent fluctuation of malaria trends in the study area, malaria cases occurred in almost every month and season of the year. The highest peak of malaria cases observed during spring (March, April, May) in 2014-2015 and summer (June – August), The minimum malaria cases were observed during autumn (September, October, and November) even if it showed increasing since 2018. Generally, there was low malaria case observation in 2018 with all seasons of the year while sharp increment since 2019 for all seasons (Fig 4).

On other hand the overall trend of season shows that spring, summer, autumn and winter accounts 20%, 18%, 13.6% and 10% respectively.



	2014	2015	2016	2017	2018	2019	2020
Summar	2485	2051	1562	1315	517	369	4640
Spring	2615	2497	1290	1088	431	786	5286
Winter	1913	1219	622	593	307	522	1925
Autumn	1673	1271	1013	358	241	1825	3158

Figure 4: Seasonal variations of malaria cases in Bahir Dar city administration for the last 7 years (2014-2020), Northwest Ethiopia,2021

The trend of malaria cases in months varies from year to year and there were high numbers of cases observed during July to December, May and June over all year with low number of cases observed from January to April. But the highest peak malaria cases (n=2342) observed during June 2019 and low number of malaria case (n=75) observed in March 2018. (Tab. 4 and Fig. 5)

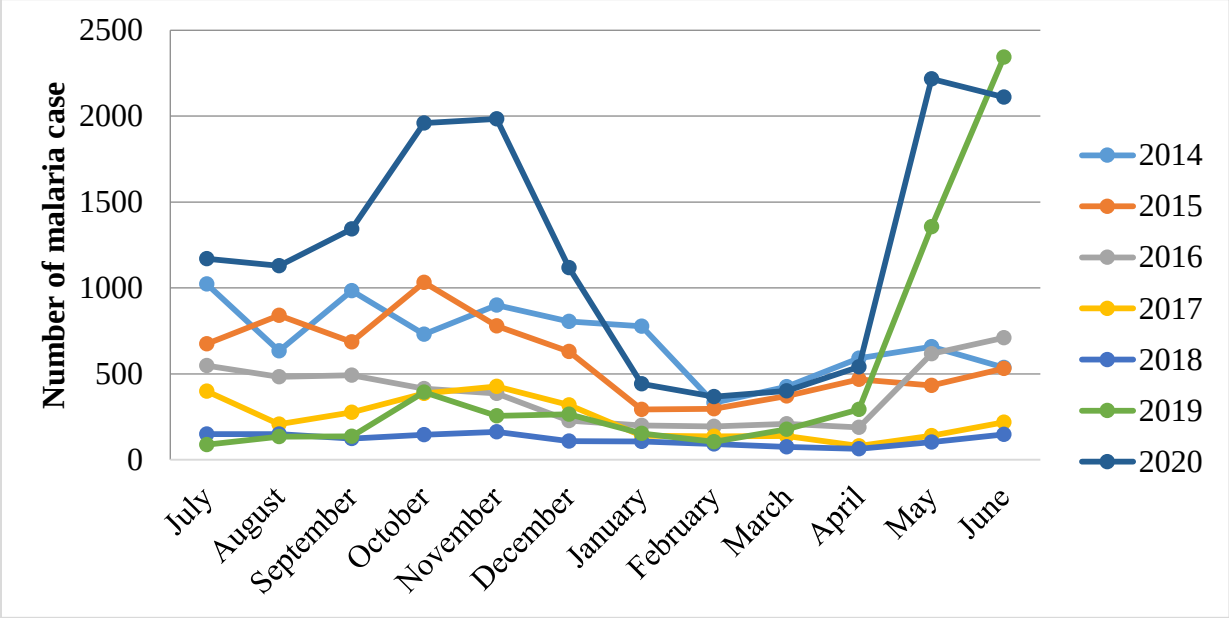
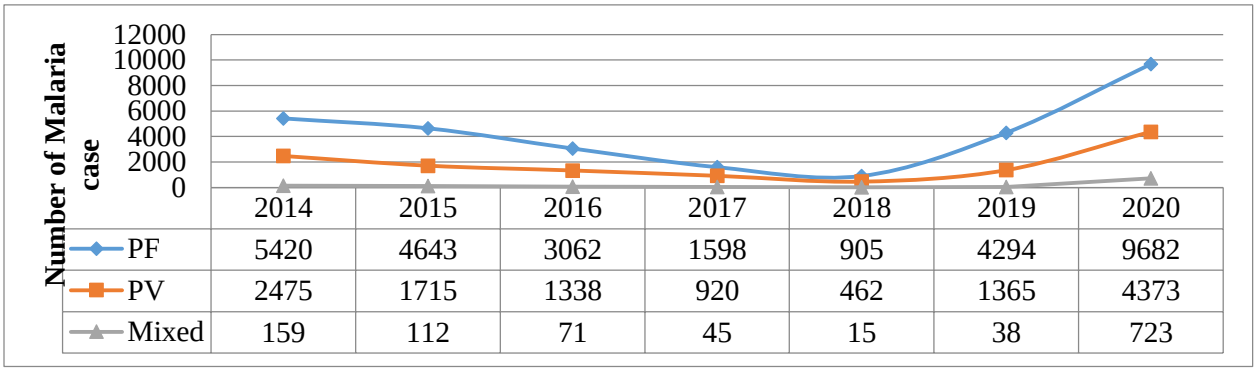


Figure 5: Monthly trends of malaria cases during the last 7 years (2014-2020),in Bahir Dar city Adiministration Northwest Ethiopia, 2021

Table 4: Distribution of malaria cases in months during 7-years in Bahir Dare city administration (2014-2020), Northwest Ethiopia, 2021

Months	Malaria cases per Year							
	2014	2015	2016	2017	2018	2019	2020	Total
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
July	1023 (28)	675 (23)	548 (11)	398 (7)	149 (3)	87 (3)	1169 (16)	4049 (13)
August	634 (16)	840 (16)	483 (10)	207 (5)	150 (3)	135 (4)	1129 (14)	3578 (10)
September	984 (20)	686 (16)	491 (11)	276 (6)	123 (3)	136 (4)	1342 (16)	4038 (12)
October	731 (18)	1032 (16)	414 (8)	386 (7)	146 (3)	394 (8)	1960 (17)	5063 (12)
November	900 (19)	779 91(20)	385 (7)	426 (7)	162 (3)	256 (6)	1984 (17)	4892 (11)
December	804 (15)	630 (10)	228 (6)	318 (7)	109 (4)	264 (7)	1117 (14)	3470 (10)
January	777 (13)	293 (8)	200 (4)	139 (1)	107 (3)	153 (4)	441 (8)	2110 (6)
February	332 (9)	296 (6)	194 (3)	136 (5)	91 (2)	105 (3)	367 (8)	1521 (5)
March	425 (9)	370 (7)	208 (3)	138 (3)	75 (2)	178 (5)	401 (9)	1795 (6)
April	590 (13)	468 (8)	188 (4)	81 (2)	63 (2)	292 (6)	541 (15)	2223 (7)
May	658 (13)	433 (8)	617 (11)	139 (3)	103 (4)	1355 (15)	2216 (30)	5521(14)
June	536 (12)	531 (10)	710 (11)	218 (3)	147 (4)	2342 (25)	2111 (28)	43588 (15)
Annual	436591 (10)							

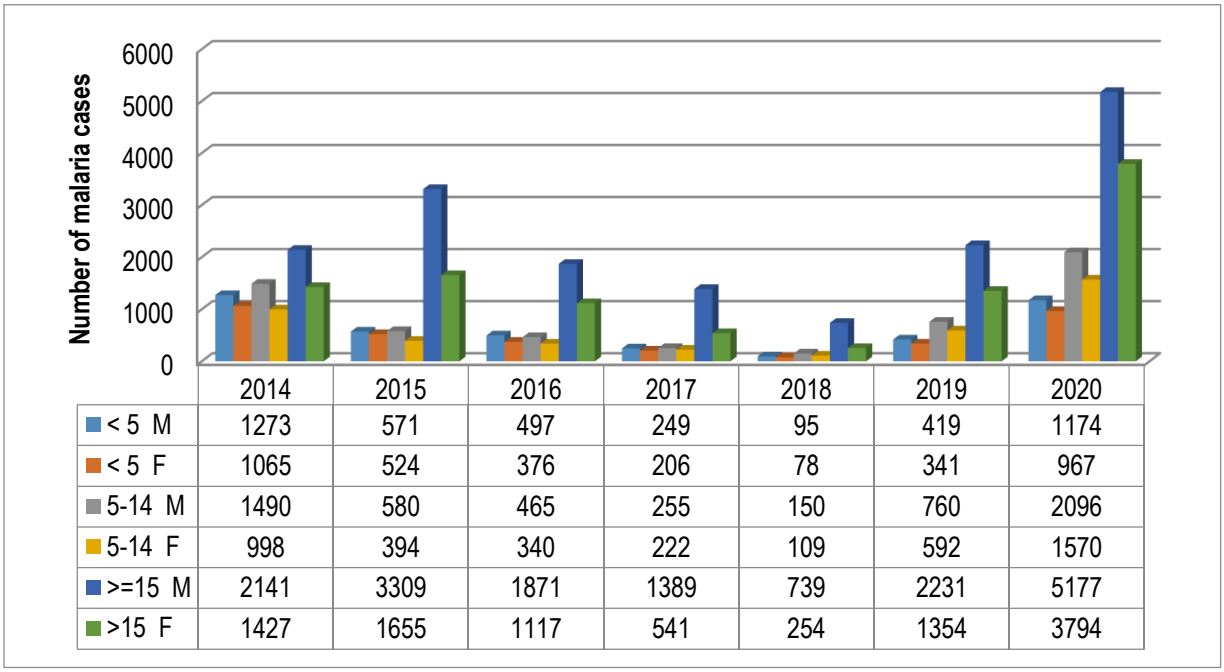
The trends in malaria parasite species follows similar line with annual trend of overall and plasmodium falciparum was predominant throughout 7 years over plasmodium vivax then mixed (plasmodium falciparum plus plasmodium vivax) (Fig 6).



	2014	2015	2016	2017	2018	2019	2020
PF	5420	4643	3062	1598	905	4294	9682
PV	2475	1715	1338	920	462	1365	4373
Mixed	159	112	71	45	15	38	723

Figure 6: Trend of malaria by specious for the last 7 years in Bahir Dar city administration (2014- 2020) Northwest Ethiopia,2021

Male malaria case with age greater than or equal to 15 years old were dominantly affected throughout the study period followed by females with the same age group and male with age group of 5 to 14 years old malaria cases were observed in contentious trend as above. (Fig 7:).



	2014	2015	2016	2017	2018	2019	2020
< 5 M	1273	571	497	249	95	419	1174
< 5 F	1065	524	376	206	78	341	967
5-14 M	1490	580	465	255	150	760	2096
5-14 F	998	394	340	222	109	592	1570
>=15 M	2141	3309	1871	1389	739	2231	5177
>15 F	1427	1655	1117	541	254	1354	3794

Figure 7: Trend of malaria cases by age and sex in seven years Bahir Dar city administration (2014-2020), North west Ethiopia,2021

6.3 Factors associated with malaria infection

The study showed that age, residence and season of the year were statistically significant with malaria infection (P-value < 0.05).

The odds of getting malaria infection was higher among malaria cases aged of 5-14 years compared to odds of malaria cases aged 15 years and above AOR= 1.53, 95% CI = (1.01, 2.31). Patients seen in summer season were twice more likely to get malaria infection compared to patients seen during the autumn season of the year; AOR =1.83, 95% CI = (1.11, 3.03). Similarly, patients diagnosed in spring season were 1.69 (1.01, 2.86) times more likely to get malaria infection compared to patients diagnosed during autumn season. In addition, patients from rural residence were 3.84 times to be infected by malaria compared to patients from urban settings (AOR =3.84, 95% CI = 2.67, 5.51) (Table 5)

Table 5: Association of risk factor with prevalence of malaria in health facilities in Bahr Dar City administration, 2020 (n=845), Northwest Ethiopia,2021.

		Result status		P-Value	COR (95% CI)	AOR (95%CI)
		Positive	Negative			
Age				.021		
	1-4 years	29	83		1.13 (0.71, 1.80)	1.10 (0.68,1.80)
	5-14	50	93		1.74 (1.17,2.58)	1.53 (1.01, 2.31)
	>=15	139	451		1	1
Season	Summer	93	191	0.003	1.895 (1.169 ,3.074)	1.83 (1.11, 3.03)
	Spring	68	195		1.396 (0.964 ,2.023)	1.69 (1.01, 2.86)
	Winter	29	132		0.85 (0.48,1.52)	1.21 (0.66, 2.23)
	Autumn	28	109		1	1
Residence	Urban	51	347	.0001	1	1
	Rural	167	280		4.05 (2.85,5.76)	3.84 (2.67, 5.51)

7. Discussion

This study attempted to see the seven years' data to see trends and seasonal distribution of malaria cases accordingly, there were 43415~ (10%) malaria cases. of them (43,415 (97%) were reported as confirmed malaria cases with the rest 1440 (3%) were clinical cases. Among tested 414766 (95%) of cases were tested by blood film microscopy and 21825(5%) were by rapid detection test (RDT) which was comparably higher than findings of 1712193(60.56%) tested by blood film microscopy and 115529(39.44%) by RDT in selected zones of Amhara region(28) . This might be related to difference in geographic area, implementation of diagnostic tests, community awareness level, and access to health facilities.

In the current study prevalence of malaria case was almost comparable with another study finding of 9.5% from southern Ethiopian(33). However, it was lower when compared to other studies in Suriname that reported a prevalence of 52.28% (26) and 19.7% prevalence from Kenya (25). And also found to be lower compared to previous Ethiopian studies: 21.8% in Gorgora and Chuahit health centers (22) and 21.8% from Boricha district Southern Ethiopia (12). The difference might be due to difference in geography and climate, attitude variation, health service quality (clinical and laboratory personnel skills in malaria parasite detection), accessibility of health facilities, community awareness about malaria transmission and control in addition to difference in national priority and COVID 19 pandemic that prevent people from early seeking health services.

In contrast, it was higher compared with 2 years' prevalence of 8.39% at East Wolega from 2018 to 2020 (34), 8.5% in Wolkite health center (15) and 6.9% in Suhul Hospital (2012-18) (13). The possible reason might be geographical area and climate conditions that have relation to malaria infection. Bahir Dar and its surroundings are known malarious areas than the comparing places due to hot climate and watery areas that comfort for the spread of mosquitoes.

From 2014 to 2018 there was also clinical diagnosis about 1440 (3%) which decrease from year to year of the malaria cases in this study area which was higher when compared with similar studies (0.04%) with the same time duration and same region (28), it might be due to understanding differences of health professionals up on diagnostic measures of malaria.

PF was most commonly isolated species that accounted for 30,044 (69%) whereas PV constituted 12648 (29 %) and mixed 723 (2%) of reported cases in 7 years. Several former studies reported similar findings where PF was most prevalent than PV; 75% PF from Ataye (30), 75% from Kola Diba (6), 50.2% from Tigray region (13), 56.3% from Boricha District (12), and 56.9% from Raya Azebo (35). The possible reason for this might be related to hot climate condition that is favorable to PF than vivax which favors colder climate conditions.

In contrast, the prevalence of malaria species in Southeast Asia which was Pv (90.8%) and Pf 7.8% (25). The difference might be due to difference in geography and climatic conditions.

Malaria in the current study showed a fluctuating order that showed a decline order up to 2018 and a sharp increasing order since 2019 in all years. The decreasing order to 2018 was supported by previous studies that showed a similar trend (12, 15). This implied that malaria control programs in Ethiopia showed almost similar status that might be due to same interventional strategies in those periods. However, the increasing order in our study since 2019 indicated the need to have timely intervention in malaria prevention and control and further community-based study to investigate potential factors of malaria infection. Since it is nationally at malaria elimination strategy, it was expected to have decreasing order. This might be possibly associated with COVID 19 pandemic that possibly limit health seeking practices of patients, make facilities busy with COVID 19, and resource shift to prevention and control of COVID 19. All these might result in low performance of malaria prevention and control programs.

This study reveals high burden of malaria in spring (20%), summer (18%) followed by autumn (13.6%) and winter (10%). The findings were similar with trend of malaria from Wolkitie (29.8%) during spring, but lower during the winter season 20.4% (11)but different from those reported in Gorgora health center where the highest prevalence was observed during Autumn which was 27.9%, followed by summer (23.3%), winter (18.4%) and (17.8%) in Spring (22). The difference might be due to difference in duration of rainy seasons and the volume of rain fall in the areas. That can determine the breading conditions of mosquitoes.

The average monthly malaria cases were high in June 6595 (15%), May 5521 (14. %) and July 4049 (13%) but it was low in January 2110 (6%), February 1521 (5%) and March 1779 (6%).

This was different from the case of Raya Azebo since the highest peak had occurred in September (35) and Halaba district in Southern Ethiopia which reported peak prevalence from September to December (33). In Kola Diba (6) the highest peak malaria case was reported in September, October and November and the minimum malaria cases were in December, January and February. The difference might be accounted in difference of warmness and availability of humidity which intensely affects malaria transmission. Due to warm climate in Bahir Dar people are more likely to sleep unprotected thereby increasing exposure to night-biting Anopheles mosquitoes even during summer. But in other areas the trend might be high in harvest seasons since agricultural workers.

Age, area of residence and season of the year were statistically significant with P-value < 0.05. Age group of 5-14 years old of age were 1.53, 95%CI: (1.01, 2.31) times more likely to be malaria infected as compare to the age category of 15 years old and above. Which is slightly similar with the study conducted in Lower Moshi, Tanganyika on malaria monitoring from 2009 to 2018 AOR 1.65 with 95 % CI: (1.28-2.13), P =value 0.001 (38). This finding was not similar with a Systematic Review and Meta-Analysis conducted in Ethiopia the pooled prevalence of malaria among adults was 13.61% (95% CI: 8.70–18.53) (37). And the study conducted in woreta health center showed age group of greater than 15 were 1.9 times more likely to be infected by malaria than under five with 95% CI (1.498-2.455) P= value 0.00 (21). The difference might be due to difference in study area.

Season of the year was also should statistical significance with malaria cases, summer and spring were the seasons on which higher cases of malaria occurred. This is in line with findings from Ataye, and kombolcha (29, 30). This might be due to the fact that these seasons are more favorable for mosquito breeding. Residence of malaria case was also one of significant variable in which rural were 3.84, 95% CI: (2.67, 5.51) times more likely infected by malaria. This might possibly have linked to environmental conditions, information access, facility coverage, health seeking practices, and difference in the use of ITN. Usually, rural areas lack the above-mentioned variables that result in high chance of getting malaria.

8. Strength and Limitations

Strength: This study used large data sets, seven years of malaria data that is better to estimate malaria trends and evaluate the performance of malaria prevention and control programs.

Limitation: since this study was based on secondary data, it lacks data quality, mainly completeness, and accuracy that might have impact on to make generalization. It has also limitation on identifying important variables associated with malaria infection.

9. Conclusion

Prevalence of Malaria in Bahir Dar city administration was still a public health burden with a fluctuating trend that indicated a sharper increasing up to 2020. Plasmodium falciparum is a predominant specious followed by Plasmodium Vivax. The distribution was high among Males and populations older than 15 years old. Although the transmission is all year round, the burden of malaria in the city was high during summer season followed by spring from overall data analysis. Age group, residence and season of the year were statistically significant factors associated with malaria infection in the study area.

10. Recommendation

- Since the recent years, the transmission of malaria has shown an increasing trend and this is not in line with the elimination target of malaria. Therefore, it required a comprehensive intervention to avert these trends.

APHI and Bahir City health office

- Strengthen preventive interventions with a special focus for the rural parts of the city administration.
- Inform the community and stakeholder to take preventive measure during the high pick seasons of malaria (summer and spring).
- It is also better if the documentation system of health facilities and health departments improved to have quality and comprehensive data.
- The trend of malaria infection showed a sharp increasing order since 2019, so special attention is needed as equal as COVID 19 due to the area is malaria's.
- Further community-based study using both quantitative and qualitative methods is suggested to know the exact status of malaria and identify important factors associated with malaria infection.

For health facilities and health extension workers

- It is better if they give more attention to rural areas for awareness creation, community mobilization and service the community as passive and active approaches.
- Improving healthcare data management is important to improve evidence-based decision-making practices.
- Enhancing facility based health education to patients and their care givers might help to improve malaria prevention and control performances.

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12. Appendixes

12.1 Check list /format

Month	Year	Total_OPD	Total Tested	BF Done	RDT Done	Total case	Total confirmed	Clinical Case	Total PF	Total Vivax	Total BF positive	Total Mixed Positives	Blood film P. falciparum	Blood film P. vivax	Total RDT positive	RDT P. falciparum	RDT P. vivax	< 5 year Malaria cases_OPD	5-14 Year Malaria cases_OPD	≥15 year Malaria cases_OPD
Jul																				
Aug																				
Sep																				
Oct																				
Nov																				
Dec																				
Jan																				
Feb																				
Mar																				
Apr																				
May																				
Jun																				
Jul																				
Aug																				
Sep																				
Oct																				
Nov																				
Dec																				
Jan																				
Feb																				
Mar																				
Apr																				
May																				
Jun																				

12.2 Check list /Format to collect Malaria data from selected health facilities to determine associated factor of malaria prevalence 2020

ID	Facility	Month	Name of Facility	sex	Age	Residence	Test Type	Result status	Specious	
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
-										
-										
-										
845										