Facility-based Retrospective Study on Malaria in Wondo Genet, Sidama Regional State, South Ethiopia

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A Thesis Submitted to School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for Degree of Master of Science in Biology (General Biology)

September 2021

Addis Ababa, Ethiopia

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ACKNOWLEDGEMENTS

I am grateful indeed to the Almighty GOD, the Merciful and Compassionate. Second, I express my deepest gratitude to my advisor Hassen Mamo (PhD) for his constructive and consistent follow-ups and guidance throughout the work devoting their valuable time. Third, I would like to my special thanks to Wondo Genet health office workers that gave me relevant information about the prevalence of malaria in their health center. Fourth, I would like to thanks Institute of Review Board of Addis Ababa University for constrictive comments and MOSHE for financial support. Lastly, I would like to thank my family, relatives, friends and others who helped me and contributed helpful and smart on advice in accomplishing my thesis.

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Acronyms

ACT	Artemisinin-based combination Therapy
CDC	Centre for Disease Control and Prevention
CFR	Case Fatality Rate
CQ	Chloroquine
FNOH	Federal Ministry of Health
HEWs	Health Extension worker
HSDP	Health Sector Development Program
IRS	Indoor-Residual spraying
ITNs	Insecticide Treated Net
LLIN	Long Lasting Insecticidal Nets
MIS	malaria Indicator Survey
MOH	Ministry of Health
MOP	Malaria Operational Plan
MOSHE	Ministry of Science and Higher Education
PCR	Polymerase chain Reaction
RDT	Rapid Diagnostic Test
SNNPRs	Southern Nation, Nationalities and Regional States
UNESCO	United Nations Educational, Scientific and cultural Organization
USAID	United States Agency

ABSTRACT

Currently, malaria is a widely prevalent and poses a serious challenge although elimination is the agenda. The main objective of the study was retrospective assessment of malaria in health-facilities of Wondo Genet district, Sidama Regional state, south Ethiopia. A retrospective design was employed in order to gather information. This was done by reviewing the past five-year (2015-2019) malaria morbidity records of the district. During this period a total of 15,218 thick and thin Giemsa stained blood films were examined and 3530 (23.20%) microscopically confirmed malaria cases were reported as a decreased inter-annual trend. *Plasmodium vivax* and *plasmodium falciparum* accounted for 50.9% and 49.1% of the cases respectively. Although malaria was reported in all age groups and both sexes, ≥15 year age group and males were more affected. However, the prevalence of malaria infection between males and females was not statistically significant (P>0.05) and, not among age groups. Despite the apparent seasonal fluctuation of malaria trends in the area, the peak of malaria cases was reported during June, August and September within the last five years. Although malaria was in a decreasing trend, it remained a significant public health threat in this particular area. Therefore, intervention measures need to be strengthened to effectively reduce the burden of malaria in Wondo Genet.

Keywords: Malaria, Plasmodium, Prevalence, Retrospective study, Wondo Genet

1. INTRODUCTION

1.1 Background

Malaria is an infectious disease that has a major impact on global public health and the economy, with an estimated 3.4 billion people at risk. Currently, malaria threatens almost one third of the world's population in 104 tropical countries and territories where it is considered an endemic disease. The World Health Organization (WHO) estimates that 207 million cases of malaria occurred globally in 2012 and led to 627,000 deaths. Africa, South-East Asia and the Eastern Mediterranean were the regions with the highest numbers of reported cases and deaths reported, mainly in children under five years of age (WHO 2013). Malaria is caused by a protozoan belonging to the genus, Plasmodium, which are obligate intracellular protozoa. *P. falciparum* (60%) and *P. vivax* (40%) are the two key causes of malaria. *P. falciparum*, *P. vivax*, *P. ovale*, *P. malaria*, and *P. knowlesi* infect humans and *P. falciparum* is the most highly virulent species and is responsible for nearly all of the 1.7–2.5 million deaths worldwide caused by malaria and *P. falciparum* remains the single most important threat to public health at a global scale, accounting for more than 90% of the world's malaria mortality (Baird, 2013).
Mosquitoes of the Anopheles genus are the vectors of the Plasmodium species, the causative agents of malarial disease. More than 400 species of the Anopheles mosquito have been described and approximately 70 these species are potential vectors of malaria that affect humans (Sinka et al. 2012).

In Ethiopia, malaria burden have been reduced over the last two decades due to improved coverage of key malaria interventions through-out the country (FDREMH report, 2015 and Tafesse *et al*, 2018). Even though these gains, in the previous years, malaria still remains the leading cause of outpatient visits, health facility admissions and inpatient deaths (FMOH, 2012). In 2016, there were an estimated 2,927,266 new malaria cases and 4782 deaths (Girum *et al*, 2016). Furthermore, 30% of the overall disability adjusted life years (DALYs) are lost, making it a significant impediment to social and economic development (PMI, 2008). The most predominant and widely distributed parasites in Ethiopia are *P. falciparum* and *P. vivax*, constituting 60% and 40% of malaria cases, respectively (FMOH, 2012).

Around 68% Ethiopian landmass is considered endemic for malaria, putting 60% of the total population more at risk of contracting the disease (EPHIENMIS, 2016). The transmission intensity and levels of malaria risk show marked seasonal, inter-annual and spatial variability; with the exception of the southwestern low land area where transmission is year-around (Zhou *et al.*, 2016). Malaria transmission become high from September to December following heavy summer rainy season and lower transmission lasts from April to May following short rainy season in most regions of Ethiopia. Also, prevalence and incidence of malaria vary depending on variations in socio-demographic risk factors, including age and sex. The unstable transmission patterns along with environmental modifications often make the country prone to cyclic epidemics occurring every 5 to 8 years (FDREMH report, 2015, EPHIENMIS, 2016). For this reason, to monitor and measure the impact of interventions, monitoring malaria burden and trend in endemic areas is critical. However, such useful data remain scarce in several endemic areas of Ethiopia, particularly in parts of SNNP Regional State.

1.2 Statement of the problem

According to World Malaria Report (2015) malaria is among the most frequently occurring and distracting phenomenon that affects an average 26,400,000 (27% of total population) reside in malaria high transmission areas (>1 confirmed cases per 1000 population), 39,600,000 (41%) in low (1 case per 1000 population) and 31,000,000 (32%) malaria free (0 cases per 1000 population) in 2014. Children, particularly under -five, including newborns and infants less than12 months of age are one of the most exposed groups affected by malaria bearing 69% of the above deaths point out that in high malaria transmission areas infants become vulnerable to malaria at approximately 3 months of age. When immunity acquired from the mother starts to go down and are becoming at increased risk of rapid disease progression, severe malaria and death, severe anemia, hypoglycemia and cerebral malaria are features of severe malaria which are particularly common in this age group (WHO, 2016).

A large peak in malaria case occurs during the major transmission season from September to December, following the main rains June to August. The second transmission seasons in April and May following short rains are a second but less pronounced peak occurs. Due to this unstable and seasonal transmission pattern of malaria in the country, protective immunity of not

only children but the general population is low and all age groups are highly vulnerable to the disease. Thus the public health burden of malaria is huge in Ethiopia (FMoH, 2015).

There were no studies conducted on the problem so as to investigate the prevalence of malaria in five health facilities of Wondo Genet (Chuko, Kela, Wosha, Aruma and Babo) were selected. Therefore, this study focuses on the retrospective assessment of malaria in health-facilities of Wondo Genet for the last five years (2015-2019).This study was, therefore, designed with the following objectives.

1.3 Objectives

1.3.1 General Objective

The general objective of the study was Facility-based retrospective study of malaria in Wondo Genet, Sidama Region, Southern Ethiopia.

1.3.2 Specific Objectives

- To determine the prevalence and yearly pattern of malaria among patients who attended in health-facilities of Wondo Genet between 2015 and 2019.
- To identify Plasmodium species involved in health-facilities of Wondo Genet.
- To identify sex and age distribution of malaria among patients attended in Health-facilities of Wondo Genet

1.4 **Significance of the study**

It is obvious that the global malaria status is the sum total of each country status, and in turn the country status is the sum total of its regional and local situations at each level. Accurate assessments of the levels and time trends in malaria burden are crucial for the assessment of progress towards goals and planning national health services and focusing future efforts (R.E.Cibulskis *et al*., 2009)

Despite the aforementioned studies at different parts of the country, malaria situation with regard to its trend, seasonal patterns, and distribution, particularly the case of the last five years' period, remains unknown in the study area. Therefore, this study was aimed at determining the trend of malaria occurrence in the Health-facilities of Wondo Genet over the last five years' period from

2015 to 2019 according to Ethiopian Calendar (E.C). The study provides scientific evidence that would be an important data base of local, national, and global relevance in advancing current knowledge on malaria situation. It is also useful to policy makers and program planners at each level for assessing progress and focusing future efforts while providing evidence-driven public health action in preventing and controlling malaria incidence.

1.5 Limitation of the study

The study was conducted in Wondo Genet Health facility. The scope of the study was delimited to the Retrospective assessment of malaria in health-facilities of Wondo Genet. Due to time and budget it did not include the prevalence and incidence of other than disease malaria.

2. REVIEW OF RELATED LITERATURE

2.1 Global burden of malaria

Malaria is one of the leading causes of morbidity and mortality in the world, with an estimated 3.3 billion people at risk of malaria. Malaria disease burden and spread can be assessed using incidence or prevalence in human hosts. According to the latest world malaria report, released on November 2015, there were 216 million cases of malaria in 2014, up from 211 million cases in2013. In 2010, an estimate of 219 million cases of malaria was reported by the World Health Organization and despite endless struggles to prevent its spread 660,000 people died from the infection that year. However, the same year, a systematic review assessed the global malaria mortality rate and revealed numbers exceeding over 1.2 million deaths, so the true malaria burden might be underestimated (Murray, 2012).

In the world there are an estimated 3.3 billion people are at risk of being infected with malaria and developing disease, and 1.2 billion are at high risk to acquire the disease. The burden is heavies in the WHO African Region, where an estimated 90% of all malaria deaths occur, and in children aged less than 5 years, which account for 78% of all deaths (WHO, 2014). It estimated 660,000deaths in 2011 directly attributed to malaria, approximately half of the world s population being at risk of infection. The disease remains one of the major challenges for people's health and livelihood around the world (WHO, 2015). Nearly half of the world s population is living under the risk of malaria. As per the WHO estimates, 91 countries and territories had an ongoing transmission of malaria in 2015 with 212 million identified cases and 429,000 deaths. Most number of cases was reported from the African Region, followed by the Southeast Asia Region (WHO, 2016). WHO recently launched the GTS for malaria, which aims to reduce the incidence and mortality rates of malaria at least by 90% by 2030.

2.2 Malaria in Ethiopia

Malaria morbidity and mortality have been significantly decreased in Ethiopia in the past decade. Ethiopia’s fight against malaria started many years ago and transmission of this infectious disease significantly decreased since 1959. However, malaria still remains a major public health problem in Ethiopia. Ethiopia has a population of more than 100 million, and it is estimated that ~ 68% of the population is at risk of the disease. Plasmodium falciparum and P. vivax co-exist as major parasite species in Ethiopia (WHO, 2017). This epidemiologic feature

makes malaria control more complicated than in most African countries where P. vivax has low or nil endemicity. Malaria transmission in Ethiopia occurs mainly at altitudes < 2000 m, although endemic regions > 2000 m have been reported (FMoH, 2010). The levels of malaria risk and transmission intensity, however, show marked seasonal, inter-annual and spatial variability, with the exception of the southwestern international border low land area where transmission is year-around (Zhou *et al.*, 2016). In most regions of the country, the major transmission season is from September to December, following the main rainy season from June to September. There is a short transmission season from April to May following the short rainy season in some regions.

Anopheles arabiensis is the predominant vector with An. pharoensis, An. coustani, An. funestus and An. nili having a minor role in transmission. Generally, the diverse ecology of the country supports a wide range of transmission intensities ranging from low-seasonal to high-perennial transmission. For planning purposes and targeting of intervention strategies, the Federal Ministry of Health (FMoH) of Ethiopia has stratified the country's malaria transmission burden using 'woreda' (district)-level transmission intensity according to annual parasite incidence per 1000 population (API) and elevation. Accordingly, four broad strata were identified by the mixed criteria of the FMoH and World Health Organization (WHO) malaria free, low, moderate, and high transmission. Plasmodium falciparum are endemic in many regions of the country. Plasmodium malariae and P. ovale infection are uncommon and account for < 1% of confirmed malaria cases (FMoH, 2010). Chloroquine (CQ) is currently the recommended first-line drug for treatment of vivax malaria. In vivo monitoring of uncomplicated vivax malaria cases indicates that the CQ is generally efficacious; however, treatment failures have been reported. The success of malaria control efforts has largely depended on financial support from donor funds. In the past decade Ethiopia has made significant strides in expanding coverage of key malaria interventions throughout the country. Indoor residual spraying (IRS) using dichlorodi-phenyltrichloroethane (DDT) was introduced in 1959 with the global malaria eradication campaign, and since then different chemical insecticides have been used for malaria control (AIRS, 2016). Insecticide-treated nets (ITN) were introduced in 1997 as an additional intervention. Chloroquine was the first line treatment of all malaria species in Ethiopia before 1998. It was replaced by sulfa doxine-pyrimethamine (SP) after 1998 for the treatment of uncomplicated P. falciparum due to widespread decline in the efficacy of CQ. Parasites soon developed resistance to SP drugs.

Planning for scaling-up malaria prevention and control interventions started in 2003 with the support from the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM) (*Kassa et al.*,2005). In 2004, the FMoH introduced artemisinin-based combination therapy (ACT) as the first-line drug for treatment of P.falciparum malaria as well as rapid diagnostic tests (RDT) to improve diagnosis and long-lasting insecticidal nets (LLINs) as a method of preventing transmission of parasite from mosquitoes to people. Major scale-up began in 2005 with country-wide distribution of RDTs, ACTs, LLINs and implementation of IRS.

2.3 Etiology of malaria Disease

A protozoan parasite belonging to the Genus Plasmodium causes malaria with five species: *P. falciparum, P. vivax, P. ovale, P. malaria,* and *P. knowlesi* infect humans (Snow, 2005) and is transmitted to humans through a bite from one of 40 species of female An. mosquitoes. Plasmodium is transmitted by mosquitoes. Female mosquitoes belonging to the genus An. are responsible for plasmodium transmission. Of over 430 An. species, only 30-40 transmit malaria in nature and Anopheles gambiae complex is the most prominent plasmodium vector in Africa. Themosquitoes which act as vector for this disease are female An. funestus, An. moucheti, An. gambiae, An. arabiensis (Karl *et al*., 2014; WHO, 2015). *Plasmodium falciparum* is responsible for almost all of the 1.7–2.5 million deaths worldwide caused by malaria and *P. falciparum* remains the single most important threat to public health at a global scale, accounting for more than 90% of the world's malaria mortality. A fifth Plasmodium species named *P. knowlesi*, that previously was known to only infect macaques, has also newly been shown to be able to infect humans (Baird, 2013). Although certain evidence advises that *P. falciparum* coevolved with Homo sapiens, other observations show that it may have emerged first in a non-human host such as the chimpanzee. Parasite was discovered in 1880 by Alphonse Laveran (Mendis *et al.*, 2009).

Africa had no malaria before and according to Nandi elders, malaria was introduced into Africa by African soldiers who participated in First World War in 1918 and 1919 and after coming back, 25% of the indigenous population got the disease (Lindsay and Martens, 1998). The relationship between humans and malaria may date back several million years (Escalante *et al*., 1998). Among several Plasmodium species that cause human malaria naturally,

P. falciparum is by far the most severe and widespread. *P. vivax* malaria, traditionally observed as a relatively benign form of the disease, is the next dominant species and can also be a major cause of morbidity and mortality, in infants and young children. A recent study from India reported *P. vivax* as a cause of acute respiratory distress syndrome which is commonly associated to *P. falciparum.* *P. ovale* and *P. malariae* are relatively rare and are usually not life-threatening (Cox-Singh, 2008).

2.4 Transmission and Life cycle

The disease is spread by the bite of infected female An. mosquitoes (Mockenhaupt *et al.,* 2002), which inoculates the parasites with its saliva at the time of biting. The disease is due to infection with one of four species of the Plasmodium genus, which are obligate intracellular protozoa (WHO, 2014). The cycle starts when an infected female An. mosquito bites an individual and injects sporozoites, present in mosquito s salivary glands, into the host blood stream during its blood meal. These sporozoites migrate to the liver where they mature and multiply within hepatocytes. These forms are known as schizonts. This extra-erythrocytic stage is asymptomatic. And usually lasts 6 days to 14 days, although sometimes it can last up to several months or even years in the case of *P. vivax* or *P. ovale.* These two human Plasmodium species can produce hypnozoites in the liver (Markus, 2011).

The life-cycle of vector -borne diseases like malaria is complex relative to that of many directly-transmitted human. The malaria parasite life cycle involves two hosts. On the whole, directly transmitted diseases require a threshold level and complexity of population agglomeration, and are therefore relatively recent phenomena perhaps evolving within the last 10 millennia (Anderson and May, 1990). Hypnozoites are a dormant form of the parasite, also called cryptic form, which can stay in the liver for long periods of time and are the cause of the disease relapse. After the liver stage, tens of thousands of merozoites will be released into the blood; where they will invade and develop within erythrocytes. The blood stage of infection includes asexual forms of the parasite that undergo repeated cycles of multiplication in erythrocytes, causing parasite numbers to rise rapidly which is responsible for the symptoms of malaria. Within the erythrocyte, the asexual forms of the parasite permits through different sequential maturation stages: ring, trophozoite and schizont forms. In the end, the

erythrocyte ruptures and new merozoits are released and ready to infect new erythrocytes. Some parasites will grow into the sexual forms, responsible for transmission, known as gametocytes. The female and male gametocytes (macro-gametocyte and micro-gametocyte, respectively) will be ingested by the mosquito vector during its feeding, and sexual reproduction occurs inside the mosquito midget before the parasite is transmitted to another human host and the whole cycle starts again (Greenwood *et al*., 2005).

The intensity of transmission depends on factors related to the parasite, the vector, the human host, and the environment (WHO, 2014). The transmission intensity is highly sensitive to environmental variations that affect the densities of these vectors and their ability to transmit the infection. Temperature influences the length of larval development, mosquito survival, and parasite development. Elevated temperatures accelerate the development rate of both the mosquito larvae and of the Plasmodium parasites (Paaijimanset *et al.,* 2009). Variations in transmission intensity have been observed within very small localities due to geographical (the geographical distribution of these species varies; *P. vivax* infection is rare in Africa but Negash *et al., 2005;* Ghebreyesus *et al., 2006).*

2.5 Signs and symptoms of malaria

The symptoms include fever and flu-like illnesses such as shaking, chills, headache, muscle aches, tiredness and general feeling of discomfort. Nausea, vomiting and diarrhea may also happen. Malaria can cause anemia and jaundice because of harm of red blood cells. As these symptoms are so general, malaria is often misdiagnosed clinically. Most malaria signs and symptoms begin 1-4 weeks after the infective mosquito bite. Inadequately taken malaria prophylactic medicines, however, may elongate the incubation period. The symptoms of malaria are and the asexual (blood- borne) stage of the parasite are similar (Newton *et al*., 1998). The first symptom of malaria is viral illness which leads to following symptoms:- Abdominal discomfort, Headache, Joint aches, Muscle aches, Abdominal discomfort, Vomiting, Lethargy, Anorexia. According to WHO first symptoms of malaria are fever, headache, chills and vomiting that are not specific to malaria. If not preserved within 24 hours, malaria due to *P. falciparum* can progress to severe illness that can lead to death (WHO, 2014).

Asymptomatic infections can occur in endemic area because of partial immunity development (WHO, 2010). Children with severe malaria can grow one or more of the following

symptoms: severe anemia, respiratory distress due to metabolic acidosis, or cerebral malaria. In general, symptoms include periodic chills and fevers, malaise, lethargy, headache, nausea, abdominal pain and sometimes vomiting and diarrhea. *P. falciparum* is the major strain that can cause severe disease such as severe anemia, cerebral malaria, pulmonary edema, acute respiratory distress syndrome and renal failure, and thus is the strain causing most deaths (White *et al., 2013).*

2.6 Diagnosis and treatment

Malaria diagnosis is usually made by examining a peripheral blood slide for the presence of parasites. Malaria microscopy uses a blood film test (WHO, 2010). While a single positive blood test result may evidence the existence of malaria, a single negative test is insufficient to exclude it. If malaria is suspected at least three negative blood film tests can be done to rule out it. In skilled hands, this is still the most sensitive means of detecting infection Rapid Diagnostic Tastes (RDTs) are also employed. RDTs, by which parasite antigens are detected in a drop of blood applied to a test strip, have become more widely available in recent years, but their cost remains prohibitive in many countries. The currently available RDTs detect one or more of the parasite anti-gens, HRP2 lactate dehydrogenase and aldose and are usually specific for *P. falciparum* infections or mixed infections containing *P. falciparum*. Malaria indicative signs and symptoms are important for its diagnosis. In most SSA, there is insufficient staff or resources available to perform blood tests whether by microscopy or by RDTs – on every patient with suspected malaria. In much of the world where malaria is endemic, asymptomatic infection is common and the presence of parasites in the blood does not equate to disease (Baired, 2013). Malaria is treated with certain types of prescription medicines depending on the Plasmodium species detected, level of disease severity, patient age, pregnancy status and the overall malaria control policy of the country in question. If untreated, *P. falciparum* malaria may lead to death particularly in under-five children within hours of the onset of signs and symptoms. Severe malaria during pregnancy can also result in failure, low-birth weight infants, developmental disabilities and other related later difficulties (Clark, 1915; Cot and Deloron, 2003).

Malaria control is mostly based on prompt case detection and treatment in addition to vector control measures. Treatment of Malaria most available anti-malarial drugs were

designed to target the symptomatic blood stages and thus act only against the sexual blood forms (Baired, 2013). Chloroquine succeeds as the first-line treatment for *P. vivax* infections in Ethiopia (including other SSA countries) (Mekonnen *et al*., 2014). Drugs are used to prevent (chemoprop hylaxis) and treat infection in individuals. While many new anti-malarial drugs have been developed in the last 20 years (mefloquine, halofantrine, artmisinin, malarone, atovaquone and proguanil, co-artemether) (Mohammed *et al*., 2015). Treatment of an individual diagnosed with *P. falciparum* malaria is of great concern because contrary to the other species, it can be rapidly fatal (White *et al.,* 2013). Individuals can protect themselves against malaria by wearing protective clothing and using insect repellents and bed nets (Zerihun *et al.,* 2007). ACT, distribution of LLINs, and IRS are important in the reduction of malaria burdens (WHO, 2015; Griffin *et al.,* 2010).

3. **MATERIALS AND METHODS**

3.1 Description of the study Area

The study was conducted in Wondo Genet town, which are about 270km to the south of Addis Ababa and 24km to the east of Hawassa city. Wondo Genet is bordered with Oromia in the west, Melga Woreda in the east, Habella Tula Kifle Ketema in the south and Oromia Region in the north. The result of analysis of data from National Meteorogical Service (NMSA) from Hawassa showed that the range of mean monthly minimum and maximum temperature of the study area are 10.2 and 30.1 0c in the month of December and February respectively. The agro ecology of the woreda has 23% humid and 77% sub-humid tropical climate and receives a mean annual rainfall of 1163mm per year. Short rain season is between March and May and accounting for 28% and long rain season is between July and October accounting for more than 50% of the total annual rainfall (Tuasha *et al* 2019).

The Town has an average elevation of 1880 meters above sea level. The area is known for its cash crops including sugarcane and khat (*Catha edulis*), enset (*Enset ventricosum*) and maize (*Zea mays*) are major food crops in the area. The wondogenet forestry plantation is prominent in the area with several small-scale irrigation canals that irrigate various crop farms including the above. The area is known for its malaria endemicity.

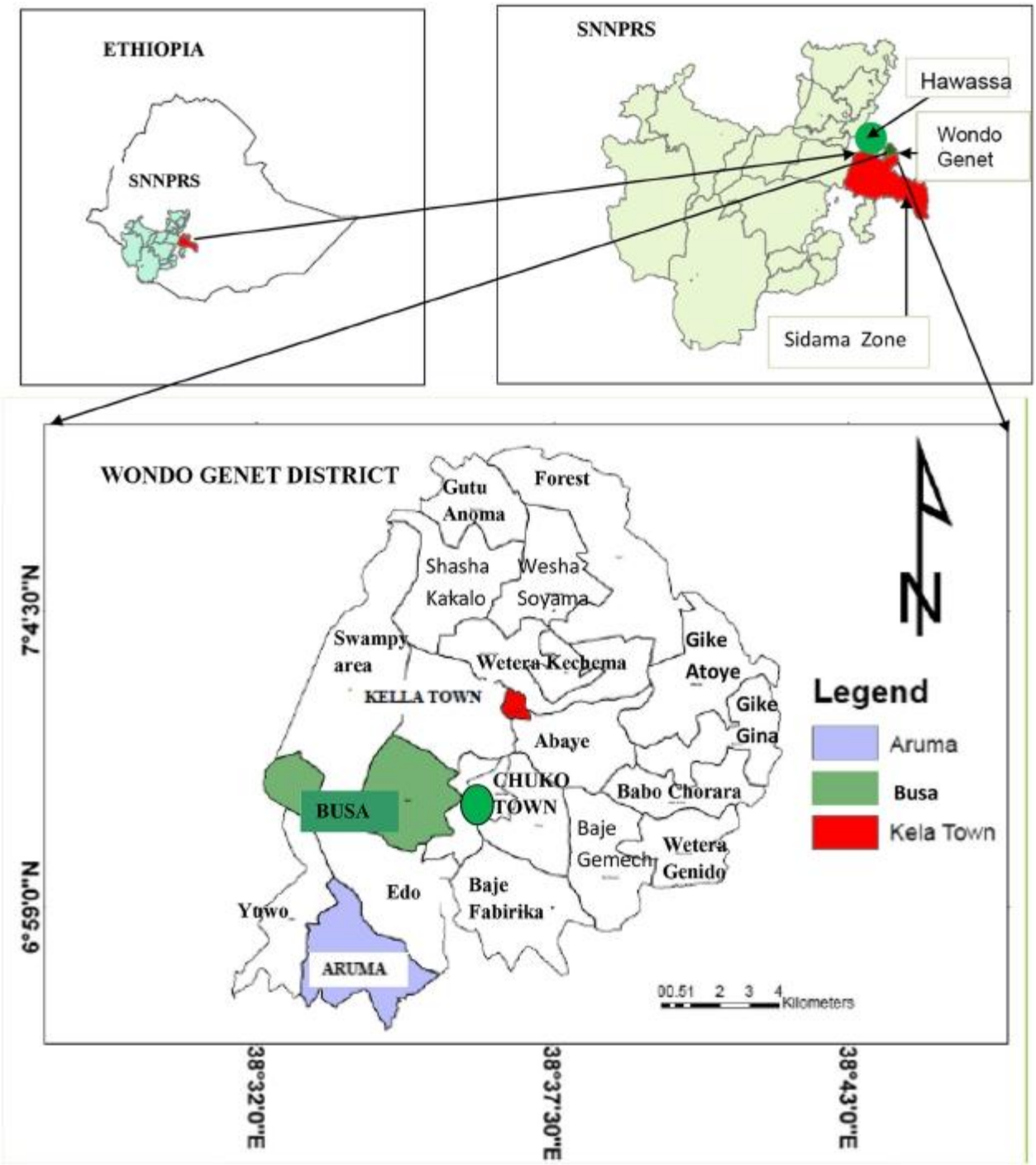

Figure -1: Map of study area (source: Tuasha *et al* 2019 BMC Infectious Diseases)

3.2 Study Design

A retrospective design was employed using data from health-facilities of Wondo Genet. This was done by reviewing past five-year (2015 - 2019) malaria morbidity records of the Health Centers.

3.3 Data Collection

Residents of Wondo Genet district who visited Wondo Genet Health Center complaining febrile illness during the study period and parasitologically examined for malaria were considered. Socio-demographic and laboratory data were collected from patients' registration book. In this health center, the staining technique and blood film examination for malaria parasite detection are conducted according to a standard operating procedure (SOP) adopted from WHO protocol (WHO 2010).

3.4 Data Analysis

Data was entered into Microsoft Office Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 20. Chi-squares (X^2) test was used to test differences in retrospective malaria prevalence between years, sexes, age groups and seasons. $P<0.05$ was considered statistically significant.

3.5 Ethical Considerations

The study was approved by the Addis Ababa University College of Natural and Computational Sciences Institutional Review Board (IRB/46/2020). After discussing the purpose and method of the study, written permission was sought from the head of Wondo Genet Health facility.

4. RESULTS

4.1. Annual Trends of Malaria Prevalence

Within the last five-year (2015 - 2019) a total of 15218 blood films were requested for malaria diagnosis from the five Health Facilities of Wondo Genet and 3530(23.20%) were microscopically confirmed as malaria cases. There was a decreasing trend of malaria with the maximum 2885(47.16%) confirmed malaria cases in 2015 and the minimum 47(2.5%) in 2019 (Table 1).

P. falciparum and *P. vivax* were the major causative agents for malaria infection in the study area. Both species were reported in the last five years with *P. vivax* and *P. falciparum* showed nearly similar occurrence. On the whole 1770 (50.14%) and 1760 (49.86%) of the cases were attributed to *P.vivax* and *P. falciparum* respectively. The difference was not statistically significant (P>0.05). There were higher *P. vivax* monoinfections in 2016(54.98) and 2019(51.06%) than *P. faciparum* (45.01% and 48.94%) respectively), and the reverse was observed in 2015 and 2017. It appeared that there was a negligible trend shift from *P. vivax* to *P. falciparum* and vice versa and the distribution was more or less stable.

Table 1 Slide-confirmed annual malaria cases and distribution of *Plasmodium* species in Wondo Genet (2015 - 2019)

Year	Examined	Positive, n(%)	*P. falciparum*, n(%)	*P. vivax*, n(%)	P-value
2015	6118	2885(47.2)	1452(50.3)	1433(49.7)	0.054
2016	3110	391(12.6)	176(45.0)	215(54.9)	
2017	2113	126(5.9)	69(54.8)	57(45.2)	
2018	1997	81(4.1)	40(49.4)	41(50.6)	
2019	1880	47(2.5)	23(48.9)	24(51.1)	
Total	15218	3530(23.2)	1760(49.9)	1770(50.1)	

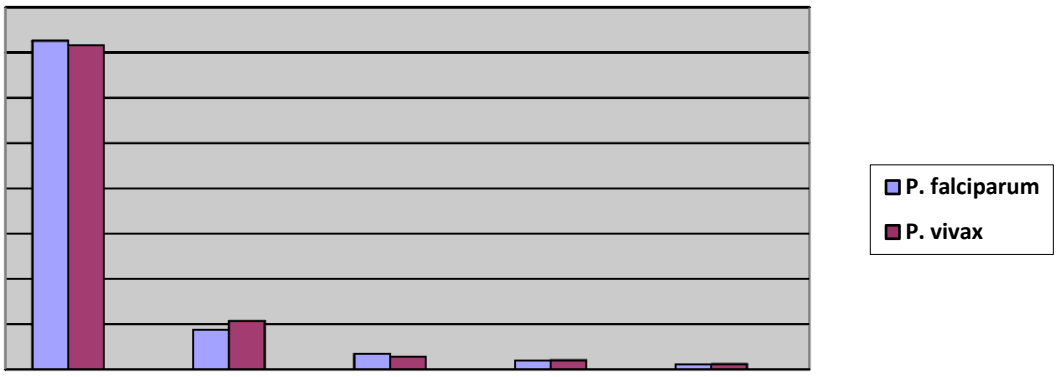

Figure-2: Annual malaria cases and distribution of Plasmodium species in Wondo Genet (2015 - 2019)

4. 2. Prevalence of malaria with respect to sex and age groups

In terms of sex, 8027 of the total examined patients were males and 7191 females. Out of the malaria slide-positive individuals, 1856(52.6%) were males and 1674(47.4%) females (Table 2). Males were more affected than females although the difference was not statistically significant.

Table-2**:** Sex distribution of malaria cases by sex at Wondo Genet Health Center, Wondo Genet, South Ethiopia (2015 - 2019)

Year	Examined	Positive n (%)	Male n (%)	Female n (%)	P-value
2015	6118	2885 (47.2)	1536 (53.2)	1349 (46.8)	0.102
2016	3110	391 (12.6)	198 (50.6)	193 (49.4)	
2017	2113	126 (5.9)	50 (39.7)	76 (60.3)	
2018	1997	81 (4.0)	44 (54.3)	37 (45.7)	
2019	1880	47 (2.5)	28 (59.6)	19 (40.4)	
Total	15218	3530 (23.3)	1856 (52.6)	1674 (47.4)	

Regarding distribution of malaria prevalence by age groups, out of 3530 total positive tests, 27.7% of the positive tests were in the age group of <5, 32% of the positive tests were in the age group of 5-14 and 40.3% positive tests were in the age group of >14. The data showed that the highest malaria prevalence was observed in the age groups of 15 and above 15 years (Table 3). However, the prevalence of malaria among age groups was not statistically significant (P>0.05).

Table 3 Distribution of malaria slide-confirmed cases in Wondo Genet Health Center in Wondo Genet (2015 - 2019)

Age	Examined	Positive n (%)	*P. falciparum* n (%)	*P.Vivax* n (%)	P. Value
<5	3462	976 (27.7)	492 (50.4)	484 (49.6)	0.078
5-14	4651	1131 (32.0)	565 (49.96)	566 (50.04)	
>14	7101	1423 (40.3)	701 (49.26)	722 (50.74)	
Total	15218	3530 (100)	1760 (49.86)	1770 (50.14)	

4.3. Seasonal variation of malaria prevalence at Wondo Genet Health Center (2015-2019)

A seasonal distribution of malaria cases is indicated (Table 4). The highest malaria prevalence 599(16.9%) was observed during August followed by June 546(15.5%) and September 503(14.3%). However, no malaria cases were recorded in the months of November, December, April and May. The occurrence of *P. vivax* was higher than *P. falciparum* in each month except in October, January and June.

Table 4 Seasonal variation of malaria prevalence in Wondo Genet, south Ethiopia (2015 - 2019)

Month	Examined	Positive n (%)	*P. falciparium* n (%)	*P. vivax* n (%)	p-value
September	1234	503 (14.25)	244 (48.5)	259 (51.5)	0.038
October	1336	488 (13.82)	245 (50.2)	243 (49.8)	
November	915	0	0	0	
December	921	0	0	0	
January	890	205 (5.8)	107 (52.2)	98 (47.8)	
February	1129	414 (11.73)	206 (49.76)	208 (50.24)	
March	1269	412 (11.67)	204 (49.51)	208 (50.49)	
April	1464	0	0	0	
May	617	0	0	0	
June	2489	546 (15.47)	282 (51.65)	264 (48.35)	
July	683	363 (10.28)	177 (48.76)	186 (51.24)	
August	2271	599 (16.97)	299 (49.92)	300 (50.08)	
Total	15218	3530 (100)	1760 (49.86)	1770 (50.14)	

4.4 Discussion

In this study, a total of 3530 (23.20%) malaria prevalence among patients were reported in the last five years, period from 2015 to 2019. This was lower than the study conducted Abeshge district, Walga Health Center (Yimer *et al.,* 2015) in which the overall prevalence of malaria was (33.8%). My finding also showed that the highest number of malaria slide- positives was in 2015 and then after declining trend continued with the lowest number of cases in 2019. This is because of increasing awareness of the community about the transmission and prevention methods of malaria. If this trend of declining of malaria prevalence continued, it will be totally controlled in the study area in the next two decades (2030).

From the result of the study the higher plasmodium species detected was *P. vivax* (50.14%) followed by *P. falciparum* (49.86%). This result is different from the study conducted in Kola Diba Health center in which *P. vivax* accounted 75% and *P. falciparum* accounted 25% (Alemu *et al*., 2013). But other studies reported that the most prevalent species was *P. falciparum*. The study conducted in Metema Hospital reported that *P. falciparum* accounted 90.7% and *P. vivax* 9.3% and mixed infection 0.3% (Getachew *et al.*, 2013). However, this study contradicts with the study conducted similarly, a research conducted in Arsi Negele in which the prevalence of *P. falciparum* and *P. vivax* was 19.8 and 74% respectively and mixed infection was 6.2% (Mengistu and Solomon, 2014). The nationwide picture, in Ethiopia which indicates that *P. faliciparum* and *P. vivax* are the two predominant parasites distributed in the country and accounting for 60% and 40% of malaria cases respectively (FMOH, 2012).This might be observed variation on climate in study area.

The data showed that males (52.6%) were more infected than females (47.4%) but without any significant statistical difference. This is in line with other studies in Ethiopia (Getachew *et al*., 2013). According to the study conducted at Kola Diba Health Center males were more affected than females. The infection rates among males were 52.6% and females were 47.3%. The reason why malaria affected more males might be due to the fact that males engaged in activities outside their residence area, migration which make them more prone to infective mosquito bites as compared to female counter parts which are mostly at home and are not exposed counter parts which are mostly at home and are not exposed to malaria areas and protected from such infects bites.

Regarding the age groups, malaria infection was recorded from all age groups in the study area. However, the rate of infection was high in the age groups 15 and above years old followed by 5-14 years old.

In the study area, seasonal variation of malaria prevalence differs in each month of the year. The highest prevalence of malaria cases was observed during June, August and September and there was no any malaria cases observed during November, December, April and May This might be due to shortage of moister or in the study area after October the rain season become highly decrease. This is not in concurrent with other studies done in Kola Diba Health Center in which malaria transmission peaks from September to November (Getachew *et al.*, 2013).

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The following conclusions were drawn based on the findings of the present study.

- There was a decreasing trend of malaria within the last five years with the maximum 2885(47.2%) confirmed cases in 2015 and the minimum 47(2.5%) in 2019.
- Both *P. falciparum* and *P. vivax* were reported. Overall, *P. vivax* was slightly higher, and no mixed-infection cases.
- Males (52.6%) were more affected than females (47.4%) although the difference was not statistically significant.
- The highest malaria prevalence (40.3%) was in the 15 years and above and the lowest (27.7%) in under-5.
- The distribution of malaria showed seasonality with the highest prevalence in June, August and March.

5.2 Recommendations

Based on the findings of the study, the following are recommended to minimize malaria burden in Wondo Genet.

- Although the study showed a decreasing trend, malaria remains a public health problem in Wondo Genet and increasing control efforts is necessary to achieve better.

- Seasonal variations require more focused attention to better control malaria transmissions and potential outbreaks.

- Community-based studies are recommended for better understanding of malaria transmission dynamic including delineation of risk factors in the study area.

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DECLARATION

I hereby declare that this M.Sc. thesis is my original work and has not been presented for a degree in any other university and that all sources of materials used for this thesis have been duly acknowledged.

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