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Prevalence and Determinant Factors of Malaria Infection among Patients Attending Gimbichu Primary Hospital, Soro District, Central Ethiopia, Ethiopia

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Abstract

In the world, particularly in Ethiopia, malaria has a great influence on human health and economy. This study intended to determine the prevalence, trends and associated risk factors of malaria patients visiting Gimbichu Primary Hospital, Ethiopia. To assess the trend and parasitological examination, a hospital-based cross-sectional study was carried out. To determine factors that significantly associated with infection, a bivariate and multivariable logistic regression analyses were performed with statistical significance set at $p < 0.05$. The findings of the study revealed the overall malaria prevalence of 72.4% among suspected patients. The study also revealed that males (AOR = 3.5, 95% CI; 1.5 - 3.8, p<0.001), individuals under five years (AOR = 2.8, 95% CI: 1.13 - 2.2), 5-20 years (AOR = 1.75, 95% CI: 1.1 - 1.91) and 21-45 years (AOR = 1.65, 95% CI: 1.01 - 1.49) were at higher risk. Additionally, study participants living close to mosquito breeding sites (AOR = 2.54, 95% CI: 2.53 - 4.14), rural (AOR = 2.13, 95% CI: 1.01 - 2.6), houses with thatch roof (AOR = 1.43, 95% CI: 1.01-2.30), not using bed nets (AOR = 1.51, 95% CI: 2.01 - 4.1), homes with wall openings (AOR = 1.6, 95% CI: 1.13 - 2.57), monthly income of less than 1,000 Ethiopian Birr (AOR = 2.93, 95% CI: 1.3 - 4.6), and pregnant women (AOR = 1.6, 95% CI: 1.13 - 2.57) had maximum risk for malaria infection. The analysis from the retrospective data showed the overall decreasing trend in malaria infection rates, despite the fluctuations recorded between 2015 - 2021. The study indicates that malaria is persistent and a significant public health challenge which is driven by a complex interrelationship of demographic, social and environmental factors. Plasmodium vivax infection is the most prevalent species known to cause malaria in the study area. These findings necessitate targeted interventions focusing on housing improvements, economic support, and vector control measures.

Keywords: Determinants; Malaria; Prevalence; Soro District, Trend

1 Introduction

Malaria is a contagious disease that is caused by parasitic proatozoa (Ferede et al., 2013). It has great impact on world population health and economy (Baird, 2013). It is dominantly caused by *Plasmodium falciparum* and *Plasmodium vivax*. Out of the two species *P. falciparum* is the stronger pathogenic species that causes most deaths by malaria diseases at world scale, accounting for more than 90% of the world malaria mortality (Baird, 2013; Ferede et al., 2013). The malaria disease is a severe disease particularly in children and pregnant women. Pregnant women are more susceptible due to decreased immunity during pregnancy, endangering both mother and the child. Similarly, children under five are at higher risk because their immune systems are not fully developed, with a child dying of malaria every 45 seconds worldwide.

As an infectious vector-borne disease, malaria continues to be a key public health challenge in the country, with transmission patterns varying across regions depending on climatic conditions, rainfall, and altitude. In Ethiopia, malaria is known to be dominantly caused by *P. falciparum* (60%) and P. vivax (40%) (FMOH (Federal Ministry of Health), 2018). In the country, about 75% of areas located below 2,000 meters above sea level are susceptible to malaria epidemics and the persistent risk of transmission (Girum et al., 2019). Annually, approximately 4,782,000 reported cases

and related deaths, with morbidity and mortality increasing markedly during epidemic periods were recorded in the country (Alemayehu et al., 2014). Of this, the large-scale epidemics tend to occur every five to eight years although smaller, localized outbreaks are reported annually (Tsige et al., 2011). An estimated 68% of Ethiopians, a country with a population of over 100 million people, are at risk of contracting malaria (WHO (World Health Organization), 2016).

In Ethiopia, malaria transmission shows a considerable variation across seasons, years, and geographic settings. The high impact of malaria is particularly pronounced in rural areas (Donnelly et al., 2005), largely due to proximity to mosquito breeding sites, limited coverage of control interventions, widespread poverty, low literacy levels, land-use practices and poor housing conditions (Stratton et al., 2008). Exceptionally, a yearly based transmission observation is evident in the southwestern lowland regions bordering neighboring countries (Zhou et al., 2016). The communities with lower socioeconomic status are known to be disproportionately affected (WHO (World Health Organization), 2012), because it limits access to medical care and preventative measures like indoor spraying, bed nets treatment and efficient antimalarial therapy (Yamamoto et al., 2010). The drug-resistant strains of *P. falciparum* and P. vivax have also emerged and spread, posing a significant challenge to the control of malaria which contributed to the recent increase in malaria cases in the nation (Yarcho, 2010).

The Government of Ethiopian has made significant progresses since 2005 in malaria control interventions such as diagnostic testing, rapid case treatment, and prevention strategies for pregnant women through intermittent preventive therapy. High efforts also implemented on the distribution of IRS and ITNs. However, the widespread emergence of drug resistance in parasites and insecticide resistance in vectors have obstructed efforts of malaria eradication (Abeku et al., 2015; Tafese et al., 2018), particularly in the Hadiya Zone of central Ethiopia. This situation underscores the need for continuous evaluation and monitoring of malaria control interventions to address existing gaps.

2 Materials and Methods

2.1 Study Area

The study was conducted at Gimbichu Primary Hospital which provides care for the Soro District in Hadiya Zone, central Ethiopia region. The district is about 264 kilometers south of the nation's capital, Addis Ababa. Soro District is home to a substantial population of 233,015 people, nearly evenly split between genders (115,825 men and 117,190 women), giving the hospital a wide and diverse community to serve.

2.2 Study Design and Period

An institution-based cross-sectional study was carried out between October 2022 and January 2023.

2.3 Study Population

All individuals who presented to Gimbichu Primary Hospital with suspected malaria during the data collection period and satisfied the eligibility requirements were involved in the study population

2.4 Eligiblity Criteria

Inclusion criteria: Malaria suspected patients who were consented to participate in the study.

Exclusion criteria: Malaria suspected patients who were not to give consent for participation in this study.

Sampling and Sample Size Determination All patients suspected of having malaria were consecutively selected during their visits to the outpatient department of Gimbichu Primary Hospital till the compulsory sample size was achieved. The sample size was estimated using Daniel's formula (Daniel, 2004).

$$N = \frac{z^2(1-p)}{d^2} \quad (1)$$

Where - p = 50%, because of the absence of previous malaria prevalence studies in the area, - d = margin of error at 5% and - z = 1.96 at 95% CI Consequently, the sample size was determined to be 384.

2.5 Data Collection

The structured pretested questionnaires were used to collect information on socio-demographic and economic status of study participants. Blood sample collection was done by finger prick by healthcare professional, and on the same slide both thick and thin blood smears were prepared. Throughout the data collection process, continuous monitoring and supervision were maintained. The activities performed by laboratory technicians, interviewers and nurses were closely overseen. Additionally, retrospective data spanning for seven years (2015 -2021) was retrieved from hospital registration records.

2.6 Data Analysis

Following a completeness check, the data was analyzed by using SPSS version 24. Logistic regression studies were performed to identify the relationship between a few possible risk variables and malaria infection. To determine the existence and strength of a connection, AOR at 95% CI were calculated; if p < 0.05, statistical significance was proclaimed.

2.7 Ethical Consideration

The Institutional Research Ethics Review Committee of CNCS of Hawassa University examined and approved the study proposal and ethical clearance was received (Ref.no. IRB/279/13). Additional, permission was also granted by the Hadiya Zone Health Department and the Soro District Primary Hospital. Confidentiality and privacy were strictly upheld, and participation in the study was entirely voluntary. After awareness made on the objectives of the study, participants gave their consent participation. Confidentiality was also maintained.

3 Results

3.1 Characteristics of Study Participants in Retrospective Study of Malaria in Soro District, 2015 - 2021

A total of 65,211 clients were registered in the laboratory logbooks of Gimbichu Primary Hospital. Of these, 36,132(55.4%) were males and 29,089(44.6%) were females. Between 2015 and 2021, 65,211 blood films were microscopically examined. The majority of the cases were males accounting 17,813(49.3%). Although malaria prevalence fluctuated from 2016 to 2021, there was an overall decreasing trend. Over the seven year period, a considerable malaria cases were recorded in the age 15 - 24 years old (18,718 cases, 28.7%), followed by 5 - 14 years old (15,131 cases, 23.2%). The lowest number of cases was over 54 years (8,740 cases, 13.4%) (Table 1).

Table 1: The social and demographic characteristics of microscopically examined suspected patients in Soro District, 2015 - 2021.

Socio-demographic variables	Category	Total examined (%)	Smear Microscopy Results	
			Positive (%)	Negative (%)
Sex	Male	36132(55.4)	17813(49.3)	18319(50.7)
	Female	29089(44.6)	11868(40.8)	17221(59.2)
	Total	**65221(100)**	**29,681(45.5)**	**35540(54.5)**
Age	<5	11283(17.3)	5114(45.3)	6169(54.6)
	5 - 14	15131(23.2)	5447(36.0)	9684(64.0)
	15 - 24	18718(28.7)	7674(41.0)	11044(59.0)
	25 - 54	11349(17.4)	8040(70.0)	3309(29.0)
	>54	8740(13.4)	3421(39.1)	5319(60.8)
	Total	**65221(100)**	**29681(45.5)**	**35540(54.5)**
Resident	Urban	29415(45.1)	10310(35.05)	19105(64.95)
	Rural	35806(54.9)	19371(54.1)	16435(45.9)
	Total	**65221(100)**	**29681(45.5)**	**35540(54.5)**

3.2 The Prevalence of Malaria cases by Mex and Age among the Study Population in Soro District, 2015–2021

Among the 65,211 blood films examined, 36,132 (55.4%) were males and 29,089 (44.6%) were females. Of the 29,681 individuals who tested positive for malaria, 17,813 (60%) were males 11,868 (40%) were females (Table 2).

The age specific prevalence rates of malaria was as follows: 5,114 cases (45.3%) in children under five years old, 5,447(36%) in 5 - 14 years old, 7,674 cases (41%) in the 15-24 years old, 8,040 cases (70%) in the 25 - 54 years age group, and 3,421 cases (39.1%) in individuals over 54 years old. The infections malaria was recorded along all age groups considered in the study with an overall rate of 70%. The maximum prevalence was observed in the age group of 25 - 54 years. The next highest prevalence was in children below five years old, at 45.3%, though the lowest prevalence was in the 5 - 14 years age group, at 36% (Table 2).

Table 2: The *Plasmodium* species distribution across sex and age among study participants in Soro District, 2015 - 2021

Variable	Category	Total examined (%)	Positive (%)	Negative (%)	*P. falciparum* (%)	*P. vivax* (%)	Mixed infection (%)
Sex	Male	36132(55.4)	17813(49.3)	18319(50.7)	9860(55.4)	7173(40.3)	765(4.3)
	Female	29089(44.6)	11868(40.8)	17221(59.2)	6550(55.2)	4866(41)	452(3.8)
	Total	**65221(100%)**	**29,681(45.5)**	**35540(54.5)**	**16414(55.3)**	**12051(40.6)**	**1217(4.1)**
Age	<5	11283(17.3)	5114(45.3)	6169(54.6)	2915(57)	1994(39.0)	204(4.0)
	5 - 14	15131(23.2%)	5447(36.0)	9684(64)	2724(50.3)	2521(46.0)	202(3.7)
	15 - 24	18718(28.7)	7674(41.0)	11044(59)	4014(52.3)	3400(44.3)	260(3.4)
	25 - 54	11349(17.4)	8040(70.0)	3309(29)	5017(62.3)	2734(34.0)	289(3.6)
	>54	8740(13.4)	3421(39.1)	5319(60.8)	1757(51.0)	1402(41.0)	262(7.6)
	Total	**65221(100)**	**29681(45.5)**	**35540(54.5)**	**16414(55.3)**	**12051(40.6)**	**1217(4.1)**

*The numbers inside the brackets indicate percentages (%)

3.3 Trends of Malaria Incidence in Soro District, 2015 - 2021

Figure 1 illustrates trends of malaria prevalence among patients from 2015 - 2021, based on data obtained from the malaria records of Gimbichu Primary Hospital. Over seven years period, 65,221 blood films were examined for malaria, with 29,663 (45.5%) testing positive. The annual prevalence rates were 74.5% in 2015, 54.5% in 2016, 44.6% in 2017, 58.7% in 2018, 10.4%; in 2019, 15.7% in 2020 and 13.4 % in 2021. The highest annual prevalence was recorded in 2015 at 74.5 %, significantly higher than in subsequent years. Overall, the data indicates fluctuating trends in malaria cases, with a general decrease over the seven-year period (Figure 1).

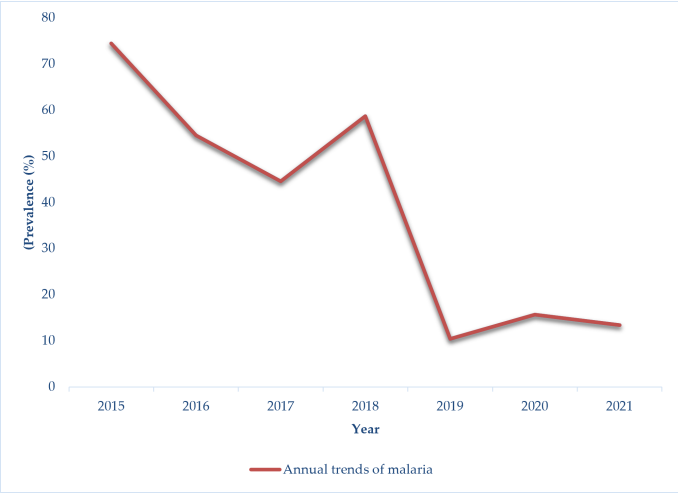

Figure 1: Malaria Incidence Trends among patients at Gimbichu Primary Hospital (2015 -2021)

3.4 Annual Malaria Prevalence Trends by Plasmodium Species in Soro District, 2015–2021

From 2015 to 2021, malaria cases at Gimbichu Primary Hospital were attributed *P. falciparum* (16,392 cases, 55.3%), P. vivax (12055 cases, 40.6%), and mixed infections (1201 cases, 4.1%). The trends in malaria cases by species showed fluctuations and an overall decrease over the years. The annual occurrence rates for *P. falciparum* were 58% in 2015, 54% in 2016, 42% in 2017, 70.1% in 2018, 42.5% in 2019, 32% in 2020, and 20% in 2021. For P. vivax, the rates were 39% in 2015, 44% in 2016, 57% in 2017, 16.9% in 2018, 56.7% in 2019, 67.6% in 2020, and 79.9% in 2021. Mixed infections were recorded as follows: 3.4% in 2015, 1.5% in 2016, 1% in 2017, 12.9% in 2018, 0.8% in 2019, 1.4% in 2020, and 1.7% in 2021. The highest case of *P. falciparum* was recorded in 2018 (70.1%), while P.vivax showed a fluctuating trend with the maximum rate in 2021 (79.9%). Mixed infection peaked in was recorded 2018 at 12.9% (Figure 2).

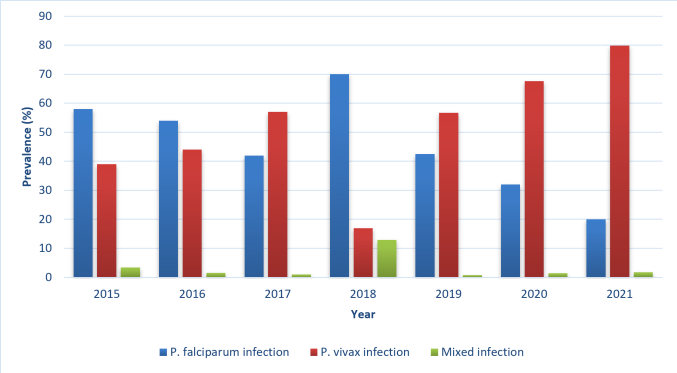

Figure 2: Malaria infection distribution trends by Plasmodium species among patients at Gimbichu Primary Hospital (2015 - 2021)

3.5 Socio-demographic Profile of the Study Population in Soro District, South-Central Ethiopia (Oct 2022 – Jan 2023)

During the study period, 384 suspected malaria patients were sampled in Soro District, comprising of 214 (55.7%) males and 170 (44.3%) females. Of these, majority of the participants (52.6%) were 5 - 20 years old, and 80 (20.8%), 58 (15.1%), and 44 (11.5%) of participants were below five years, 21 - 45 years, above 45 years, respectively. Most participants (219, 57%) resided in rural areas. The monthly income per month distribution of the study participants were: 118 (30.7%) had 3,000 - 5,000 ETB, 110 (28.6%) had less than 1000 ETB. Additionally, 199 (52%) respondents were homes near mosquito breeding sites, 237 (61.7%) respondents had homes with wall opening, 167 (43.5%) of respondents were sleeping under mosquito net,101(26.3%) respondents had IRS in the past five months, and 266 (69.3%) respondents had homes with corrugated roofs (Table 3).

3.6 Prevalence and Determinant Factors of Malaria Infection

The findings indicated that 278 (72%) of the participants were infected with malaria parasites. Analyses of determinant risk factors for suspected patients found significant associations with sex, age, residence, pregnancy status, income level, bed nets usage, IRS in the past five months, availability of mosquito breeding places, porous wall for mosquito's entrance, and types of roofing material.

Males were found to have a 3.5 times more likelihood of malaria infection compared with females (AOR = 3.5, 95% CI: 1.5 – 3.8, p < 0.001). Higher infection rates were observed for children under five years of age (AOR = 2.8, 95% CI: 1.13 – 2.2), individuals aged 5–20 years (AOR = 1.75, 95% CI: 1.1 – 1.91), and those aged 21 – 45 years (AOR = 1.65, 95% CI: 1.01 – 1.49) when compared with participants older than 45 years.

Table 3: The participants socio-demographic characteristics in Soro District, South-Central Ethiopia (Oct 2022 – Jan 2023)

Characteristics	Categories	Number	Percent (%)
Gender	Male	214	55.7
	Female	170	44.3
Age	<5	80	20.8
	5 - 20	202	52.6
	21 - 45	58	15.1
	>45	44	11.5
Residence	Urban	165	43
	Rural	219	57
Pregnancy-Self reported	Present	107	28
	Absent	277	72
Income level	< 1,000	110	28.6
	100-3,000	91	23.7
	3,000-5,000	118	30.7
	>5,000	65	16.9
Home closer to breeding site	Yes	199	52
	No	185	48
Opening hole in the wall	Yes	107	28
	No	277	72
Sleep under mosquito net	Yes	167	43.5
	No	217	56.5
IRS in the past five month	Yes	101	26.3
	No	283	73.7
House roof type	Corrugated	266	69.3
	Thatch	118	30.7

Participants living in households around mosquito breeding sites in the surrounding environment were nearly three times more likely to be infected than those without such sites (AOR = 2.54, 95% CI: 2.53–4.14, p < 0.001). Rural residents had approximately twice the odds of malaria infection compared with urban dwellers (AOR = 2.13, 95% CI: 1.01–2.6, p = 0.01).

Housing characteristics were also showed significant association with malaria infection. Individuals residing in houses with thatched roofs were 1.43 times more likely to be infected compared to those living in houses with corrugated iron roofs (AOR = 1.43, 95% CI: 1.01 – 2.30, p < 0.001). Participants who did not use bed nets had a higher risk of malaria infection than their counterparts who used bed nets (AOR = 1.51, 95% CI: 2.01 – 4.1). Similarly, the existence of wall openings in dwellings increased the likelihood of malaria infection by 1.6 times (AOR = 1.6, 95% CI: 1.13 – 2.57, p = 0.01).

Furthermore, participants with a monthly income of less than 1,000 Ethiopian Birr were infected with malaria nearly triple times when compared with those earning more than 1,000 Birr per month (AOR = 2.93, 95% CI: 1.3 – 4.6, p = 0.004) (Table 4).

Table 4: Logistic Regression Analysis for Predictors of Malaria in Suspected Patients in Soro District, Central Ethiopia, (Oct 2021 – Jan 2022)

Characteristics	Category	Malaria+ve(%)	COR(95%CI)	P-value	AOR(95%CI)	P-value
Sex	Female	106(62.4)	1		1	
	Male	172(80.4)	1.67(1.3 - 2.65)	< 0.001	3.5(1.5 - 3.8)	< 0.001
Age	<5	27(34)	1.6(2.13 - 3.1)	0.01	2.8(1.13 - 2.2)	0.024
	5 - 20	161(79)	1.86(1.14 - 2.16)	< 0.001	1.75(1.1 - 1.91)	< 0.001
	21 - 45	50(86)	1.75(1.01 - 2.79)	0.03	1.65(1.01 - 1.49)	0.03
	>45	40(90)	1		1	
Residence	Urban	110(66.7)	1		1	
	Rural	168(76.7)	1.43(1.14 - 2.31)	< 0.001	2.13(1.01 - 2.6)	0.01
Income level of Household	< 1000	90(81.8)	1.55(1.06 - 4.62)	< 0.001	2.93(1.3 - 4.6)	0.004
	100-3000	65(71.4)	0.56(0.22 - 5.6)	0.324	0.86(0.21 - 5.2)	0.31
	3000-5000	83(70.3)	1.63(0.11 - 2.6)	0.234	2.75(0.14 - 4.3)	0.22
	>5000	40(61.5)	1		1	
Use of bed nets	Yes	112(67.1)	1		1	
	No	166(76.5)	1.54(2.03 - 5.12)	< 0.001	1.51(2.01 - 4.1)	< 0.001
IRS in the past twelve month's	yes	70(69.3)	1		1	
	No	208(73.5)	1.9(1.23 - 2.96)	< 0.001	1.89(1.3 - 2.76)	< 0.001
Mosquito Breeding Site near to home	Yes	145(72.8)	1.54(2.03 - 5.16)	< 0.001	2.54(2.53 - 4.14)	< 0.001
	No	133(71.9)				
Home wall opening	Yes	67(62.6)	1.89(1.23 - 2.96)	< 0.001	1.6(1.13 - 2.57)	0.01
	No	211(76.2)	1		1	
House Roof Type	Corrugated iron sheet	191(71.8)	1		1	
	Thatch	87(73.7)	1.63(1 - 2.2)	0.02	1.43(1 - 2.30)	0.001

*For each respective characteristic, the percentage calculated is from total examined

3.7 Discussion

This study was conducted to examine trends in malaria infection over time, estimate its prevalence and identify factors associated with malaria infection among patients attending Gimbichu Primary Hospital in Soro District, South-central Ethiopia.

A study by Deressa et al., 2006 reported that malaria has been one of the major causes of mortality, hospital admissions and outpatient visits in Ethiopian health facilities for a long time. In line with these findings, the present analysis showed that malaria cases peaked in 2015, accounting for 74.5% of all reported cases, while the lowest prevalence was observed in 2019 (10.4%). From the year 2015- 2021, overall trend analysis demonstrated the fluctuations in malaria incidence, with an overall declining pattern across the seven-year period.

Results from the current study revealed an overall malaria prevalence of 72.4% among suspected patients. This prevalence differs from reports of similar studies conducted in other parts of Ethiopia either higher or lower. For instance, the prevalence rate observed in this study was higher than those reported from Dilla District by Ehsetu and Besha, 2015 , Kola Diba District by Abebe et al., 2012, Wolkite Health Center by Degefie, 2017, Arba Minch Hospital by Belayneh, 2014, Sibu Sira District by Girum, 2014 and the East Shewa Zone of Oromia Region by Firew and Andrew, 2018. In contrast, it was lower than the prevalence reported from Hallaba District by Girum (2014). These differences might be due to variations in study period, season, altitude, local communities' awareness and differences in malaria prevention and control strategies.

In the study area, P. vivax was the predominant Plasmodium species (86.1%), followed by *P. falciparum* (8.3%) and mixed infections of *P. falciparum* and P. vivax (5.6%). Hence, the result of present study contradicts with the national estimates which indicate as *P. falciparum* accounts for approximately 60% of malaria incidences while P. vivax accounts for the remaining 40% in Ethiopia (Eliyas, 2014). Similar predominance of *P. falciparum* has been documented in studies conducted in Ayire District (Eliyas, 2014) and Arba Minch Hospital (Belayneh, 2014). Such inconsistencies may be explained by topographical differences, as *P. falciparum* transmission is more common in lowland areas. Conversely, the predominance of P. vivax observed in this study is agree with reports from Wolkite Health Center (Degefie, 2017) , Dilla District (Ehsetu & Besha, 2015), Hallaba District (Girum, 2014) , and East Shewa Zone (Firew & Andrew, 2018) **(Firew and Andrew, 2017)**. This similarity may be related to comparable altitudinal conditions or the relapsing nature of P. vivax, particularly during cooler seasons.

The present study showed as the infection malaria was significantly more common among males than females which seem males being 3.5 times more likely to be infected. This result differs from case reported by Graves et al., 2009 , although it is consistent with other Ethiopian studies (Abebe et al., 2012; Girum, 2014). More than half proportion of the malaria infection was observed among individuals aged 5–20 years, followed by those aged 21–40 years. This may be attributed to increased outdoor activities such as farming and other productive work, which elevate exposure to mosquito bites. Additionally, malaria prevalence was assumed to be higher among individuals residing in rural areas when compared with those living in urban settings. This observation aligns with findings from Dilla District (Ehsetu & Besha, 2015). Such higher burden in rural areas may be due to lower levels of awareness, substandard housing conditions, limited resources and reduced access to effective malaria control measures.

The record of the higher prevalence of malaria cases among pregnant women when compared with non-pregnant women probably due to immunity reduction associated with pregnancy. Low household income may also significantly associate with increased malaria infection. For instance, individuals with lower income levels may face greater malaria risk due to limited access to preventive tools and healthcare services, inadequate housing that permits mosquito entry, and compromised health and nutrition status (Dejene, 2014). These findings are also consistent with studies from Muleba District in the Kagera region of Tanzania, which reported a similar association between family employment status and malaria prevalence among children under five (Mushashu, 2012). WHO (World Health Organization), 2012 also pointed out as economically disadvantaged households may have limited access to healthcare facilities and insufficient resources to afford vector control

interventions including insecticide-treated nets (ITNs), indoor residual spraying (IRS) and antimalarial medications.

The result of present study regarding the use of indoor residual spraying within the past 12 months was significantly associated with malaria infection. In similar way, Sintasath et al., 2005 also indicated as IRS remains a cornerstone of the national malaria control strategy, particularly for epidemic prevention and mitigation. Their study also has shown substantially reduces in malaria morbidity and mortality. These findings are also consistent with reports from the Jiga area in northwest Ethiopia (Seble, 2014) , although they contrast with findings from Muleba District in Tanzania (Mushashu, 2012).

For the malaria infection, the environmental and housing-related factors such as proximity to mosquito breeding sites, wall openings, wall type and roofing material were identified as important contributors. These results agree with previous studies conducted by Ghebreyesus et al., 2000 and Loha, 2013 which have highlighted the role of housing quality and environmental conditions in malaria transmission.

4 Conclusions

The findings of this study indicated that malaria remains a major public health concern in Soro District; P. vivax was identified as the predominant infecting species. Although retrospective analysis over the seven-year period revealed fluctuations in malaria incidence, the overall trend showed a gradual decline. Several factors were significantly associated with malaria infection, including low household income, proximity to mosquito breeding sites, the presence of wall openings, lack of indoor residual spraying, and inadequate use of insecticide-treated bed nets.

Addressing existing burden of malaria in the study area requires coordinated and multi-sectorial interventions. The control efforts should be prioritize to strengthen the health service accessibility and quality, prompt treatment of infected individuals, enhancement of community socio-economic conditions, implementation of effective and well-coordinated vector control measures. The active community engagement action is also needed to mitigate the identified risk factors in Soro District, Ethiopia.

Declarations

Availability of data

The data used during this study will be available up on request.

Conflict of interests

The authors declare no conflict of interest.

Consent for publication

Not applicable.

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None

Authors' contributions

MB was responsible for conceptualization, investigation, data collection, analysis and writing the original draft. TA, MK and GG contributed to supervision, methodology, data analysis and reviewing and editing the manuscript. All authors read and approved the final manuscript.

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