Previous Trend, Present Prevalence and Integrated Knowledge, Attitude and Practice Towards Malaria and Use of Insecticide-treated Mosquito Net in the Rural Setting of Welkait District, Northwest Ethiopia

Tsegay Gebremariam Yhdego

Addis Ababa University College of Natural Sciences

Asnake Desalegn Garedew

Addis Ababa University College of Natural Sciences

Fitsum Tigu Yifat (✉ fitsum.tigu@aaau.edu.et)

Addis Ababa University <https://orcid.org/0000-0001-9741-0062>

Research

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Welkait district, northwest Ethiopia**

Tsegay Gebremaryam¹, Asnake Desalegn² and Fitsum Tigu^{2*}

¹Department of Zoological Sciences, College of Natural Sciences, Addis Ababa University,
Addis Ababa, Ethiopia.

²Department of Microbial, Cellular and Molecular Biology, Division of Microbiology, College
of Natural Sciences, Addis Ababa University, Addis Ababa, Ethiopia.

* Corresponding Author

Email address: fitsum.tigu@aau.edu.et (FT)

Abstract

Background

Malaria is still a burden to Ethiopia, especially among the productive ages of the society. Although insecticide-treated mosquito nets (ITNs) are widely used by the rural community, malaria remains a leading public health issue. This study aimed to evaluate a 5-year trend, current prevalence and community knowledge, attitude and practice (KAP) towards malaria and use of ITNs as a strategy for prevention of malaria among the rural setting of Welkait district, northwest Ethiopia.

Methods

A cross-sectional study was carried out on 403 households to identify the prevalence rate of malaria. Besides, a 5-year (2015-2019) retrospective data was analyzed. Random sampling technique was used to select representative households among the community. Well-structured questionnaire were used to collect KAP data about malaria and utilization of ITNs. Blood samples were collected and examined for identification of malaria parasites using standard microscopic procedure. SPSS version 22 was used for the analysis of the quantitative data.

Results

Of 36,219 outpatients examined, 7,309 (20.2%) malaria-positive cases were reported during 2015-2019. Overall prevalence of malaria continually declined from 2015-2019. Male slide-confirmed (61.4%, $N = 4,485$) were significantly higher than female (38.6%, $N = 2,824$) ($p < 0.005$). Nineteen (4.7%) confirmed malaria cases were screened during parasitological survey (12 cases of *P. falciparum* and 7 cases of *P. vivax*). Most 78.4% (316) and 84.1% (339) of the respondents knew malaria is a communicable and curable disease respectively and 75.6% (239)

of them associated it with mosquito bit. From 82.4% (332) respondents who believed malaria is preventable, 81.0% (269) of respondents considered ITNs as the main prevention method. About 64% (257) of the respondents possessed ITNs, of these, 66.9% (172) consistently used ITNs during the peak season. Majority 83.6% (337) of the respondents had a positive attitude towards ITNs.

Conclusions

Although the retrospective data showed a declining trend of malaria in the district, the current prevalence survey revealed significant increase in malaria infection in the locality. This was due to by unsustainable distribution and inconsistent use of ITNs among the population. We recommend the governments and stockholders to give emphasis on full coverage of ITNs and educate the community about ITNs usage.

Keywords: Attitude, ITNs, Knowledge, Malaria, Practice, Prevalence, Welkait district, Ethiopia.

Introduction

Malaria is an infectious protozoal disease, transmitted by the bite of parasite-carrier female *Anopheles* mosquitoes. The causative agent belongs to the genus *Plasmodium*, that consists of five well known species, namely *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale* and *P. knowlesi* which commonly cause malaria in humans [1, 2]. *P. falciparum* and *P. vivax* are the most common and widely distributed species in Ethiopia that account for 60% and 40% malaria cases respectively [3]. Among the several Anopheline species that transmit malaria to humans, only *Anopheles arabiensis* is recognized as primary vector in Ethiopia, while others *Anopheles pharoensis*, *Anopheles funestus* and *Anopheles nili* are considered as the secondary vectors [4].

The disease is primarily tropical diseases of most developing countries of the world; which are severely affecting their economy and public health [5]. Overall world malaria cases decreased

from 251 million in 2010 to 228 million in 2018, however, Africa still bears the biggest burden of morbidity with 93% cases [6]. Despite high morbidity, Africa also recorded the highest absolute reduction of mortality in 2018 (380,000 deaths) compared to 2010 (533,000 deaths) [6]. Likewise, the world malaria associated mortality rate declined in 2018 because of the expansion of prevention and control measures. Nevertheless, Sub-Saharan Africa countries are largely affected by malaria infection.

Ethiopia is one of the most malaria epidemic-prone countries in Africa with 52.7 million people (68% of the population) at risk of malaria infection, especially the most productive age groups [7, 8]. Almost 75% of Ethiopia's mainland is endemic for malaria; furthermore, the interaction of mountainous landscape with variable winds, seasonality of rainfalls, and the presences of ambient temperatures creates diverse micro-climates for malaria transmission [4, 8]. According to the Federal Ministry of Health (FMOH) National Malaria Prevention and Control Strategy, areas below 2,000 m were considered 'malarious' and prevention measures have been in place half a century ago [9, 10]. Among the most effective malaria control interventions, use of long-lasting insecticidal nets (LLINs) and indoor residual spraying (IRS) of households with insecticide are strongly recommended by WHO [6, 11].

Several reports indicated consistent and correct utilization of ITNs, particularly the LLINs are proven to reduce the transmission rate up to 90% [12-14]. Indoor residual spraying is also an extremely effective means of malaria control strategy when properly applied in areas where malaria is epidemic [11, 15]. In Ethiopia following the WHO recommendation, ITNs have been distributed in all malarious areas free of charge via health workers, volunteers and local administrators. Even though most households owned at least two ITNs per family [10], there is a knowledge gap among the community about consistent and correct use of nets to minimize the

impact of malaria in the country [16]. Full coverage and proper utilization of ITNs are vital for the prevention and control of malaria [17], still there are also limitations in sustainable distribution and timely replacement of nets, seasonality of malaria, and poor knowledge associated with malaria, ITNs and the vector. On top of it, the coverage and utilization of ITNs also differ from region to region [18].

The main determinants in the ownership and utilization of ITNs as reviewed by Singh et al. [19] educational level, knowledge of malaria, socio-economic status and parity and community participations were found to be the major factors in different settings. These factors contribute to the low efficacy (60%) of the available ITNs [19-21]. Bearing in mind, northern Ethiopia, out of the total malaria exposed households, only 74% of them received at least one ITN [22]. Hence, studying the KAP towards the use of ITNs in such limited resources is vital beside other efforts made to control malaria in the northern region. Furthermore, knowing the past, providing the current prevalence of malaria as well as integrated knowledge, attitude and practice towards utilization of ITNs, completes the protection and control efforts of malaria in the region, especially in the district. Therefore, the current study aimed to analyze the past 5-year (2015-2019) retrospective data, current magnitude of malaria and explore knowledge, attitude and practice towards malaria and use of ITNs as malaria prevention strategy in the rural community of Welkait district, northwest Ethiopia.

Methods

Study design

The study was designed to analyze triangulated data sources. A five year (2015-2019) malaria record was extracted from Maygaba Health Center (MHC) and community based cross-sectional

study was conducted to assess KAP and clinical examination of malaria was conducted to assess malaria infection.

Study area and population

This study was conducted in Maygaba town of Welkait district, northwest Ethiopia. The Maygaba town is about 929 Km from the capital city-Addis Ababa and 273 Km from Gondar city. It has five rural and one urban villages with an estimated number of 7,039 households. According to the Maygaba town communication office, each village has an average family size of 4.4 persons per household and a total population of 30,974; of which 15,642 are male and 15,332 are female. Three villages (Korarit, Maygaba and Adijamus) with a total population of 16,781 in 3,814 households were involved in the study. Male and female dwellers were 8,474 (50.5%) and 8,306 (49.5%), respectively. The population size under each selected village was 7,266 (43.3%) in Korarit, 4,962 (29.6%) in Maygaba and 4,553 (27.1%) in Adijamus. On average, each village consists of 1,271 households and 5,593 population. The villages are characterized by altitudinal range of 677 to 2,755 m.a.s.l. Its mean annual temperature is 22.5°C, with mean annual minimum and maximum temperature of 15°C to 30°C, respectively. Malaria was frequently reported annually from September to November.

Sample size determination

The sample size was calculated following single population proportion formula, $n = \left(\frac{Z\alpha}{2}\right)^2 \times \frac{P(1-P)}{d^2}$ reported elsewhere [23]. Assuming that half of the respondents have knowledge on cause and transmission of malaria and use of ITNs with an estimated malaria prevalence rate of 50% ($p = 0.5$) at 95% confidence interval ($Z\alpha/2 = 1.96$) and 5% of marginal error ($d = 0.05$). Based on the calculation, value of 384 plus 10% non-response rate, the total

estimated participants were 422. Actually 403 participants (95.5% of response rate) were included in both KAP and parasitological studies. A multi-stage cluster random sampling technique was implemented as indicated in Fig 1. A total of 96 ($422/4.4 = 95.9$) households were selected using probability proportion to size of households in the selected *Gujiles*. The proportion of households for each *Gujile* were divided by the total number of households in a given *Gujile* to determine a sampling interval for selecting households. A systematic random sampling techniques was used to select every n^{th} household and one participant per household was enrolled.

Fig 1 Flow chart indicating the multi-stage cluster random sampling technique

Data collection

Retrospective health data

The past five years (2015-2019) malaria health examination record data were collected from MHC using the format developed by the principal investigator. The malaria trends in the study area were analyzed by appropriate software.

Cross-sectional study

Well-structured questionnaires containing both close- and open-ended questions about KAP and utilization of ITNs were prepared from earlier studies associated with malaria [16, 24, 25]. The questionnaire was developed in English, translated into Amharic (national language) and checked for correctness of the translation by fluent speakers of both languages. Then questions were pre-tested by preliminary survey in some *Gujiles* and the content, completeness and suitability towards the target study was validated. Finally, the questionnaire was amended to suit the objectives of the current study and was administered to 403 randomly selected household heads during March to May 2019.

Parasitological examination

Blood samples from 403 households were collected by pricking their finger-tips with the help of laboratory technicians using disposable blood lancet. Thin and thick films were made on the slide and then properly labeled. The thin films were fixed with methanol (100%) at the site. After air drying in upright position, all the slides were placed in the slide box and carefully transported to the MHC for parasitological examination. Both the thick and thin films were stained with Giemsa (3%) solution as per the standard microscopic protocol [26]. The presence of malaria parasites in 100 fields were examined from the thick films. The thin films were used for

identification of *Plasmodium* species. About 5% of the slides were randomly selected and re-examined by the senior expert in MHC for quality control.

Data analysis

Wholeness and consistency of the data were checked twice and entered into SPSS version 20 software (SPSS Inc, Chicago, IL, USA) for statistical analysis. Descriptive statistics (frequencies and percentages) were used to tabulate and describe the cross-sectional data. The Chi-squared (χ^2) test was applied to analyze the retrospective data and determination of association between dependent and independent variables. Statistical significance was defined at p -values < 0.05 .

Ethical considerations

The study was ethically approved by the Health Bureau of Welkait district and College of Natural and Computational Sciences Institutional Review Board (CNCS-IRB), Addis Ababa University. Before conducting the investigation, the researcher discussed the study with local administrative body in the study area. All the study population were clearly informed about the purpose of the study and kindly asked to participate in the study. Blood samples were collected by trained staff of MHC and all malaria positive cases were carefully treated according to the national malaria guidelines [27]

Results

Retrospective analysis

During January 2015 to December 2019, about 36,219 patients have been diagnosed for malaria and out of which 20.2% ($N = 7,309$) were slide-positive. On average 7,244 malaria-suspected and 1,462 malaria-confirmed cases were tested by MHC every year. Variation in the number of malaria-suspected and -confirmed cases in each year was observed. Despite the variation, the

average monthly malaria prevalence was 1.7%. Generally, the overall prevalence of malaria showed a declining trend during 2015 to 2019, except a slight increase recorded in 2016 (Fig 2a and S1 Table). Regarding the distribution of sex, from the total tested cases, slightly over half (54.7%, $N = 19,797$) of patients were males and (45.3%, $N = 16,422$) were females. While from the total slide-confirmed cases, the majority (61.4%, $N = 4,485$) of them were males and the rest (38.6%, $N = 2,824$) were females. Looking at the overall male to female ratio of tested and slide-confirmed cases, mostly males were affected more frequently than females with a ratio of 1.2:1 and 1:0.6, respectively. This difference was statistically significant ($\chi^2 = 3.923$, $p < 0.05$). Consequently each year, a higher number of malaria positive males were observed than the malaria positive females, however yearly difference in the number of cases was not statistically significant ($p > 0.05$). Comparing the annual overall prevalence of malaria under each sex category, males showed higher (22.7%) prevalence than females (17.2%) (Fig 2a and S1 Table).

Fig 2 The trend of malaria at MHC, northwest Ethiopia, from 2015-2019 a) Prevalence of malaria b) Side positive cases by infection category c) Seasonal profile of malaria suspected and slide-confirmed cases d) Seasonal prevalence by malaria types

The total number of malaria examined over malaria positive cases showed great variation between seasons. With respect to the number of cases, total cases exhibited the following order: autumn > winter > summer > spring (Figs 2c and d). Majority of suspected as well as infected cases were observed soon after the main rainy season (September-November). A total of 34.2% of malaria negative and 37.5% malaria positive cases were reported in this season (S2 Table). While the smallest number of malaria-suspected (16.6%) and -infected (11.7%) cases were reported during the small rainy season (March-May). Almost the same malaria-suspected cases

(25.5 and 23.8 %) were observed in dry and heavy rainy seasons respectively (S2 Table). Significantly higher number of slide-confirmed malaria cases (37.5%) were observed during autumn soon after the heavy rainy season ($p < 0.01$) compared to dry and small rainy seasons. Generally, pairwise comparisons indicates that there are significant inter-seasonal variations ($p < 0.001$) except between autumn and summer ($p = 0.376$). Since the actual season of malaria in the study area was not clearly defined, it is not possible to calculate the prevalence of malaria for each season. Nevertheless, this imperative result tells us that malaria was observed throughout all the seasons.

In terms of infectious category, *P. falciparum* was the major (66.1%) contributor to malaria infection in the study area, while *P. vivax* accounted only (33.9%) of infection (Fig 2b and S1 Table). The difference was statistically significant ($\chi^2 = 758.8$, $p < 0.001$). Co-infection of *P. falciparum* and *P. vivax* was not reported at all during the 2015-2019 retrospective study. The overall trend of both infections showed variation between years and seasons. Apparently *P. falciparum* was the dominant infection that occurred consistently over 65% in all study years and seasons (Figs 2b and c). So, it is not surprising that *P. falciparum* was the most prevalent infection than *P. vivax* in the past five years at the study site. Despite dominance and prevalence, both infections followed similar patterns towards seasonality (Figs 2c and d). About 37.8, 31.2 and 19.1 of *P. falciparum* infection were registered in September-November, December-February and June-August, respectively (Fig 2d and S2 Table). Similarly, about 36.9, 31.8 and 20.3 of *P. vivax* cases were also recorded in September-November, December- February and June-August, respectively. Although lower number of *P. falciparum* (12%) as well as *P. vivax* (11%) cases were reported in the small rainy season than any other seasons, however, statistically significant difference was not noticed ($\chi^2 = 5.67$, $p = 0.234$).

Prevalence of malaria

Only 403 households who provide complete information were considered in blood films collection (Table 1). From which two-hundred and forty-eight (61.5%) blood donors were male. A total of nineteen slide-positives were obtained, of which twelve cases were from male and seven cases were from female. Nearly half (48.9%) of the blood film providers were the most productive age group (18-30 years) of the society with sixteen cases of malaria. While only a few number of participants (13.9%) were above 41-years. The overall prevalence of malaria in the district was 4.7% with asymptomatic infection category of twelve cases of *P. falciparum* and seven cases of *P. vivax*.

Table 1 Socio-demographic characteristics of study population diagnosed for malaria at MHC (*N* = 403)

Variables	Category	No examined (%)	Slide-positive (%)	<i>P. falciparum</i>	<i>P. vivax</i>
Sex	Male	248 (61.5)	12 (2.97)	8	4
	Female	155 (38.5)	7 (1.73)	4	3
	Total	403 (100)	19 (4.7)	12	7
Age (year)	18-30 (male)	126 (31.3)	10 (2.48)	6	4
	18-30 (female)	71 (17.6)	6 (1.48)	4	2
	31-40 (male)	80 (19.8)	1 (0.25)	1	0
	31-40 (female)	70 (17.4)	1 (0.25)	0	1
	> 41 (male)	42 (10.4)	1 (0.25)	1	0
	> 41 (female)	14 (3.5)	0 (0.0)	0	0
	Total	403 (100)	19 (4.7)	12	7

Participant demographics

During a cross-sectional survey, a total of 422 household heads or their representatives were involved. Out of which nineteen households were excluded from the analysis due to the

incompleteness of the information provided. Four-hundred three participants' information were completed with a response rate of 95.5%. The majority of the respondents were male (61.5%, $N = 248$). The details of the participants' demographic data are summarized in Table 2. Almost half (48.9%, $N = 197$) of the respondents were in the age category of 18-30 years followed by the 37.2%, $N = 150$ who belonged to the 31-40 years age group. Majority of the households consisted of greater than five people/household (62.3%, $N = 251$); over half (53.6 and 54.3%) of the respondents were illiterate and farmers, respectively.

Table 2 Socio-demographic characteristics of study population ($N = 403$)

Variables	Category	Frequency (%)
Sex	Male	248 (61.5)
	Female	155 (38.5)
Age	18-30	197 (48.9)
	31-40	150 (37.2)
	>41	56 (13.9)
Education	Illiterate	216 (53.6)
	Elementary	173 (42.9)
	Secondary	14 (3.5)
Livelihood	Farmer	219 (54.3)
	Merchant	10 (2.5)
	Student	114 (28.3)
	Housewife	57 (14.1)
	Daily laborer	3 (0.7)
Village	Korarit	164 (40.7)
	Maygaba	147 (36.5)
	Adijamus	92 (22.8)
Family size (age <18 years)	1-3 persons	46 (11.4)
	4-5 persons	106
	> 5 persons	251

Livestock ownership	Yes	349
	No	54
Ownership & type of house	Modern	231
	Conventional	172

255

256 **Knowledge and practice on malaria**

257 Majority of the participants (91.3%, $N = 368$) living in the study area had awareness of the
 258 presence of malaria in their vicinity. Similarly, most of the respondents (78.4%, $N = 316$) replied
 259 that malaria is a communicable disease, of which (75.6%, $N = 239$) knew that malaria is
 260 transmitted by mosquitoes. Two-hundred and thirty-nine respondents (86.6%, $N = 207$)
 261 recognized that night time is suitable for mosquito biting. Most (82.4%, $N = 332$) of respondents
 262 replied that malaria is a preventable disease. Among the three-hundred and thirty-two
 263 respondents, the majority (81.0%, $N = 269$) of participants knew that ITNs are the main
 264 protection tool for malaria infection. Likewise, a large proportion (84.1%, $N = 339$) of the
 265 respondents recognized that malaria is treatable if managed earlier; of whom (82.3%, $N = 279$) of
 266 the participants preferred health centers as ways of treatment (Table 3).

267 **Table 3** Malaria related knowledge and practice of the study participants ($N = 403$)

Variables	Category	Frequency (%)
Ever heard about malaria	Yes	368 (91.3)
	No	11 (2.7)
	I do not know	24 (6.0)
Malaria is a communicable disease	Yes	316 (78.4)
	No	64 (15.9)
	I do not know	23 (5.7)
Cause of malaria (n=316)	Mosquito bite	239 (75.6)
	Environmental change	44 (13.9)

	Lack of environment sanitation	33 (10.4)
When mosquitos bite mostly (n=239)	Day	15 (6.3)
	Night	207 (86.6)
	Any time	17 (7.1)
Malaria is preventable	Yes	332 (82.4)
	No	24 (6.0)
	I do not know	47 (11.7)
Prevention methods (n=332)	Apply environmental sanitation	9 (2.7)
	Use of ITN	269 (81.0)
	Fumigation	14 (4.2)
	Wearing long sleeved clothes	40 (12.1)
Malaria is treatable	Yes	339 (84.1)
	No	21 (5.2)
	I do not know	43 (10.7)
Ways of treatment (n=339)	Traditional healer	22 (6.5)
	Health centers	279 (82.3)
	Buy drug from pharmacy	30 (8.9)
	Others	8 (2.4)

Integrated KAP on utilization of ITNs

Majority of the respondents (75.7%, $N = 305$) had heard about ITN according to Table 4. Although their sources of information on ITN were varied, most (73.9%, $N = 227$) of the respondents obtained information from health workers. With regard to ITNs ownership, about 64.0% ($N = 257$) of the respondents possessed ITNs. Of the two-hundred and fifty-seven ITNs owners, 71.6% ($N = 184$) of the respondents had one ITN per family, followed by two 15.2% ($N = 39$) and three 13.2% ($N = 34$). On the other hand, from one-hundred and forty-six ITNs non-owners, 56.2% ($N = 82$) mentioned that they hadn't received ITN, while 43.8% ($N = 64$) replied that their ITN was worn-out due to wear and tear. Beside the knowledge of respondents towards

ITNs utilization, most of the participants (83.6%, $N = 337$) also have a positive attitude towards the benefits of sleeping under ITN. Out of 83.6% ($N = 337$) respondents, 87% ($N = 292$) of participants believed that ITN can protect mosquito bites. While the rest of respondents used ITN for other purposes than malaria prevention such as comfortable sleeping and others (Table 4).

Out of two-hundred and fifty-seven respondents having ITNs, a considerable number (67.3%, $N = 173$) of respondents had slept under ITN the last night before the time of interview. A similar figure (60%, $N = 154$) had the best experience of utilizing their ITN over 2 years and 40% ($N = 103$) of respondents have used on average 1.5 years. Nearly 67% (172) of the respondents commonly used the ITN during the peak season of malaria. Mostly pregnant women were given priority to use ITN among the family members (60.3%, $N = 155$), followed by mother and children under five (39.7%, $N = 102$). Despite possession, most of the respondents (74%, $N = 190$) did not re-treated their ITNs with insecticide for the second time. This was due to two main reasons; lack of awareness and lack of insecticide. However, a quarter of the households (26%, $N = 67$) were properly utilizing their ITNs with insecticide treatment (Table 5).

Table 4 Knowledge and attitude towards the use of ITN among the study population ($N = 403$)

Variables	Category	Frequency (%)
Ever heard about ITN	Yes	305 (75.7)
	No	98 (24.3)
Source of information about ITN (n=305)	Mass media (TV & radio)	65 (21.3)
	Health workers	227 (73.9)
	Local leader	13 (4.3)
ITN possessed	Yes	257 (63.8)
	No	146 (36.2)
ITNs per family (n=257)	One	184 (71.6)
	Two	39 (15.2)

	Three	34 (13.2)
Reason for ITN non-possession (n=146)	Worn-out	64 (43.8)
	Not received	82 (56.2)
Sleeping under ITN is beneficial	Yes	337 (83.6)
	No	66 (16.4)
What are the benefits of ITN (n=337)	Protect mosquito bite	292 (86.7)
	Comfortable sleep	35 (10.4)
	Others	10 (3.0)

Discussion

The five years retrospective data analysis revealed that the overall prevalence of the malaria was showing a declining trend except a slight increase observed in 2016, this was due to the occurrence of unseasonal rainfall in the study area as the information obtained from the MHC indicates. Although the health system data showed a continual declining of malaria prevalence in the study area, the current prevalence rate obtained from community based parasitological survey do not support this finding, proves that the efforts that have been made by the district as well as the regional health office to control malaria in the study area was not sufficient. This was also further identified by unsustainable distribution and inconsistent use of ITNs observed during the current community based cross-sectional study. Despite the intensification of nationwide malaria interventions such as high coverages of ITN and IRS, improved health services systems and diagnosis of malaria, there is still high incidence of malaria and major discrepancy between ITN ownership and compliance in malaria endemic areas [3]. These has been observed in most settings of sub-Saharan African countries [19]. The rise of malaria prevalence may not be necessarily associated with nationwide or universal coverage of ITN, it might be also due to an

increase in insecticide resistance, inconsistent use of bed nets and under-utilization of other methods of malaria control [28].

Table 5 Practices of the study population towards ITN utilization ($N = 257$)

Variables	Category	Frequency (%)
ITN used last night	Yes	173 (67.3)
	No	84 (32.7)
Duration of ITN utilization	1-2 years	103 (40.1)
	>2 years	154 (59.9)
When ITN used mostly	Regularly	73 (28.4)
	Malaria season	172 (66.9)
	Sometimes	12 (4.7)
Who mostly used ITN in the family	Mother and children (<5)	102 (39.7)
	Pregnant woman	155 (60.3)
Re-treated ITN with insecticide	Yes	67 (26.1)
	No	190 (73.9)
If no, what are the reasons (n=190)	Lack of awareness	89 (46.8)
	Lack of insecticide	101 (53.2)

This study revealed that the current prevalence of malaria in the Welkiat district was found to be 4.7%, this finding was much higher than the prevalence reported in other malaria endemic areas of Abeshge (0.25%) [24] and Shewa Robit town (2.8%) [25], while lower than other regions of Ethiopia such as Dembia (6.7%) [29] and Dejen districts (12.4%) [30] in northwest and east Gojam zones, respectively. Since malaria infestation and incidences depend on different factors such as climate, landscape and altitude of a given area are the factors for the inconsistencies. These differences might also arise from methodological capability and the type of diagnostic tools used, the established malaria control facilities of the areas, the study population and social settings. In contrast, the current prevalence has demonstrated the weakness

of malaria control and prevention efforts of the district. The 4.7% prevalence rate observed by community based parasitological survey revealed a 3% increment compared to both monthly (1.7%) and yearly (20.2%) prevalence calculated from MHC data. Since the household survey was conducted in the small rainy season (March to May), the prevalence might be higher than the current rate if the survey was conducted in the peak season of malaria. Thus, the current result was inconsistent with the finding of Yimer *et al.* [24] and country-wide reduction of malaria morbidity and mortality report [3].

The health record data of this study indicate that significant number of male malaria-confirmed cases were recorded in the MHC compared to the female, suggesting that males were extremely infected by malaria in the study area. The result also coincides with the finding obtained from a parasitological survey of the current study (Table 1). This finding was comparable with a similar study reported in another malaria endemic area of Ethiopia [24]. This is because males' had greater occupational risk of getting the disease than women. Males, mainly 18-40 years old are usually engaged in outdoor activity such as farming particularly, irrigation activity was mostly done during evening up to night in the study area. This was also explained by community based cross-sectional survey revealed that occupation has significant ($p = 0.013$) relationship with knowledge of malaria (Table 6). Furthermore, other behavioral risk factors might increase the risk of mosquito bites among males.

Malaria transmission was recorded throughout all the seasons in the study area, and the inter-seasonal variations were significant ($p < 0.001$). The substantial number of malaria-infected cases were reported shortly after the main rainy season. This is because the existence of cold and cloudy weather conditions during this season create a conducive environment for breeding of mosquitoes [25]. Furthermore, most cultivated crops including maize release pollen grains

following the rainy season that may serve as a food source for mosquito larvae to complete its life cycle. In both retrospective and community based cross-sectional surveys, *P. falciparum* was predominantly found in the study area and become a major (66.1%) contributor of morbidity and mortality. This is in agreement with the national report [4, 31] as well as reports from most other regions of Ethiopia [3, 29].

Table 6 Association of knowledge on malaria and ITN utilization with socio-demographic characteristics (*N* = 403)

Knowledge on Malaria and Utilization of ITN					
Characteristics	Poor (F, %)	Good (F, %)	High (F, %)	χ^2	<i>p</i> -value
Sex					
Male	75 (30.2%)	98 (39.5%)	75 (30.2%)	0.026	0.871
Female	47 (30.3%)	63 (40.7%)	45 (29%)		
Age					
18-30	58 (29.4%)	81 (41.1%)	58 (29.4%)	0.851	0.654
31-40	44 (29.3%)	62 (41.3%)	44 (29.3%)		
>41	21 (37.5%)	22 (39.3%)	13 (23.2%)		
Family size					
1-3 person	15 (32.6%)	18 (39.1%)	13 (28.3%)	3.861	0.145
4-5 person	36 (34%)	42 (39.6%)	28 (26.4%)		
>5person	71 (28.3%)	100 (39.8%)	80 (31.9%)		
Occupation					
Farmer	69 (31.7%)	86 (39.5%)	63 (28.9%)	6.219	0.013*
Non-Farmer	52 (27.7%)	89 (47.3%)	47 (25%)		
Education					
Illiteracy	75 (34.6%)	87 (40.3%)	54 (25%)	8.201	0.006*
Elementary school & above	47 (25.1%)	66 (35.3%)	74 (39.6%)		
Malaria transmission methods					
Mosquito bite	71 (29.7%)	101 (42.3%)	67 (28.0%)	7.612	0.226

Others	22 (28.6%)	26 (33.8%)	29 (37.7%)		
Malaria is treatable					
Yes	102 (30.1%)	133 (39.2%)	104 (30.7%)	16.98	0.002*
I do not know	13 (61.9%)	4 (19.1%)	4 (19.1%)		
Malaria is preventable					
Yes	100 (30.1%)	133 (40.1%)	99 (29.8%)	0.074	0.785
I do not know	15 (62.5%)	5 (20.8%)	4 (16.7%)		

* Significant at $p < 0.05$, F = frequency, % = percent

The cross-sectional study revealed that the majority (91.3%) of the respondents had considered malaria as their major public health problem and over (75%) of the respondents also identified that such disease is transmitted through the biting of mosquitoes. In this study, the awareness of the respondents was slightly lower than the findings elsewhere [24, 25], while the knowledge of the transmission of malaria in our study group was in agreement with Alelign and Petros [32]. Besides knowledge and awareness on the causes and ways of transmission among the respondents, the knowledge on mosquitoes biting time and prevention measures among the societies are quite important. In this regard, our results indicate that the vast majority (86.6%) of the respondents had knowledge on suitable biting time of mosquitoes and about 82.4% of the respondents also believed that malaria is preventable. Table 6 also shows a significant ($p = 0.002$) association between respondents' knowledge on malaria and ITNs utilization and malaria treatability. This finding was comparable with the study conducted in Shewa Robit, northeastern Ethiopia [25], but higher than a similar report in another setting [33].

Similarly, about 81.0% of the respondents mentioned the use of ITNs during sleeping as the main prevention methods from malaria disease. This result supports the respondents' knowledge towards the cause of malaria and its transmission through mosquito biting was quite high even though significant ($p > 0.05$) relationship was not observed (Table 6). The finding was

comparable with other findings elsewhere [16, 24], but lower than other reports in Woreta, northwest Ethiopia [32]. The variation may be due to the extent of malaria in the area and socio-cultural differences found in various settings. Although several treatment seeking practices were mentioned by the respondents, nonetheless the majority (82.3%) of them preferred health centers for the treatment of malaria disease. This finding was consistent with respondents in other studies elsewhere [24]. The respondents' preference might be due to the availability of health centers than zonal and referral hospitals in the rural settings. Thus, providing malaria related facilities in such centers is an important strategy for the reduction of malaria morbidity and mortality in the district.

In addition to assessing the knowledge about malaria vectors, ways of transmission and treatment seeking behaviors of the community, proper knowledge on prevention and control of the malaria as well as the vector are also important to reduce the incidence of the disease among the community. In this regard, combined KAP and ITN utilization among the rural settings are vital since the extent of understanding of the preventive and control measure varies from community to community and among individual households. Thus, taking ITN as a major malaria prevention tool [34], over three fourth of our study groups had enough information about the ITN although their sources were varied. However, the ITNs possession rate was found to be 64.0%, which was exactly consistent with 2016 countrywide coverage [3] but lower than the reports in Benishangul Gumuz (90.9%) [35], Arsi zone (84.2%) [21] and Gambella region (81.7%) [36] in Ethiopia. While higher than the study conducted in other similar studies in Raya Azebo and Harari, Ethiopia [18, 33]. This implies that even in the adjacent regions, there was variation in the ownerships of ITNs. Furthermore, this finding was contrary to the national report that every malarious region had at least two ITNs per household [10].

394 Additionally, a significant number (36.2%) of the respondents did not possess ITN and the
395 reason reported by the study participants for non-possession of ITN were, did not receive
396 (56.2%) and worn-out (43.8%). This result indicates that there was an unbalanced and
397 unsustainable distribution of ITN in the district. Therefore, regular monitoring of ITNs
398 ownership by the health extension workers and timely replacements of the worn-out ITNs by the
399 regional health office are important for effective prevention and control of malaria in the district.
400 The efficacy of ITNs depends on how regularly and consistently the ITNs are used and people's
401 perception towards utilization of ITNs [34, 37]. In our study 83.6% of households had a positive
402 attitude towards the benefits of sleeping under ITN and also about 87% of them properly
403 understood its usage. Nevertheless, only 67.3% of them used ITNs last night at the time of
404 interview. This finding was higher than similar studies in Raya Azebo and Arsi zone, Ethiopia
405 [21, 33] but lower than the report from other settings in Ethiopia [18, 24, 38]. Whereas, 16.4%
406 either had a negative attitude towards use of ITN or were uncertain about their use due to various
407 reasons as mentioned by Tarewa *et al* [16].

408 In this study we found that 28.4% and 67% of the households used ITN regularly and during
409 peak season of malaria, respectively. Interestingly, priority was given to mothers, children and
410 pregnant women in the family to use ITN. This was a common practice of most communities in
411 Ethiopia [18, 33, 38]. In terms of ITNs utilization experience, almost all the households had been
412 using their ITNs at least for one year and above. This finding was in line with the finding
413 elsewhere [38]. ITN is not equivalent to LLIN that requires the second time treatment with
414 insecticide [34], however only quarter of them treated their ITNs with insecticide for the second
415 time during long usage experiences. Due to great insufficiencies of ITNs/LLINs that limits the

full coverage of all malarious regions in Ethiopia as well as other African regions. The trend of re-treatment of ITN with insecticide and repair has to be encouraged among the society [19, 39].

Wiring the triangulated findings in this study, excellent KAP towards malaria and ITNs alone does not grant the reduction of malaria related morbidity and mortality in the study area unless and otherwise consistent usage and sustainable distribution of ITNs among the community has to be practiced regularly. This was simply explained by high prevalence of malaria in the study area obtained via community based parasitological survey and retrospective data analysis. Nevertheless, the parasitological study has to be supported by advanced diagnostic methods such as molecular diagnosis using polymerase chain reaction (PCR) to further confirm the results obtained through microscopic examination. Additionally, it could have been better to design the cross-sectional survey accompanied with direct observation of ITNs usage in the study area. Finally, it is difficult to draw better and reliable conclusions from five years of health recorded data, analyzing as much recorded data as possible may provide more qualified conclusions. However, due to poor recordkeeping at MHC and lack of malaria related follow up data, for instance morbidity and mortality data were missing and limited our study.

Conclusions

In conclusion, the overall prevalence of malaria in the study area was declined during the study period of 2015 to 2019. The community based parasitological survey discovered nineteen slide-positive cases. Majority of the people were aware of the cause of malaria, communicability, preventability and curability of the disease and identified ITNs as a main prevention method. Although the overall community's KAP and ITNs possession rate is acceptable, this does not elucidate substantial usage, sustainable distribution and timely replacement of ITNs in the study area. This negatively influenced the prevention and control effort of malaria among predisposed

societies of the locality. Therefore, urgent emphasis should be given to full coverage of ITNs, regular monitoring and replacements of old and worn-out ITNs and educate the community towards usage and retreatments of the possessed ITNs by the government and all stockholders are strongly recommended.

Supporting information

S1 Table. Suspected and slide-confirmed annual malaria cases at MHC, from 2015-2019

S2 Table. Summary of seasonal cases and prevalence of malaria at MHC during 2015-2019

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Ethics approval and consent to participate

The study was ethically approved by the Health Bureau of Welkait district and College of Natural Science Institutional Review Board (CNS-IRB), Addis Ababa University. Before conducting the investigation, the researcher discussed the study with local administrative bodies in the study area. All the study population were clearly informed about the purpose of the study and kindly asked to participate in the study. Prior to administering the questionnaires and blood sample collection, all participants agreed and signed the consent form. Blood samples were

460 collected by trained staff of MHC and all malaria positive cases were carefully treated according
461 to the national malaria guidelines.

462 **Data Availability Statement**

463 All relevant data are within the paper and its Supporting Information files.

464 **Competing interests**

465 The authors declare that they have no competing interests

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467 No specific funding was obtained for this particular study

468 **Authors' contributions**

469 All authors contributed to the study conception and design. Material preparation and data
470 collection were performed by TG. Statistical analysis and interpretation were performed by TG,
471 AD and FT. The first draft of the manuscript was written by FT and all authors commented on
472 previous version of the manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

Flow chart indicating the multi-stage cluster random sampling technique

Figure 2

The trend of malaria at MHC, northwest Ethiopia, from 2015-2019 a) Prevalence of malaria b) Side positive cases by infection category c) Seasonal profile of malaria suspected and slide-confirmed cases d) Seasonal prevalence by malaria types

Supplementary Files

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- [S1Table.pdf](#)
- [S2Table.pdf](#)