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Prevalence of Malaria and Associated Factors in Dilla Town and the Surrounding Rural Areas, Gedeo Zone, Southern Ethiopia

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Abstract

Although progress in the fight against malaria, about 75% of the land and 60% of the population is exposed to malaria in Ethiopia. The aim of this study was to assess the prevalence and associated factors of malaria in Dilla town and surrounding rural areas, Southern Ethiopia. Institution based, cross sectional study was employed from October 01 to December 29, 2014 in health facilities. A stratified sampling technique was carried out to select representative individuals. A pre-tested structured questionnaire and blood film examination format (n=350) were used as data collection tools. Peripheral blood samples were collected and the presence of malaria parasites was observed microscopically on thick and thin blood smears. Personal data were collected through the household-based questionnaires. Finally, data were entered and analyzed using SPSS version 20.0. The overall prevalence of malaria in the study area was 16.0% with higher infection rate in the surrounding area (53.6%) and amongst the age group of 15-24 years (35.7%). The predominant Plasmodium species detected was *P. vivax* (62.5%) followed by *P. falciparum* (26.8%) and mixed malaria infection of both species (10.7%). Chi-square result revealed that residing in houses with mud block walls and unavailability of insecticide treated bed nets were found to be significantly associated with the risk of getting malaria parasites ($p<0.05$). Individuals living in nearby stagnant water were found to be two times more likely to get malaria parasites than those who were far away from these risky areas (OR=2.01, 95% CI: 1.50-3.85). Houses that had been sprayed with insecticide in the past 6 months were protected against malaria infection (OR=2.45, 95% CI: 2.20-3.99). In conclusion, the prevalence of malaria reported in the current study was higher than reports in many areas of the country despite its reduction from year to year.

Keywords: Malaria prevalence; Dilla town; *Plasmodium*; Health center

Introduction

Malaria is the world's most deadly parasitic disease and is caused by infection with single-celled parasites of one of the four species of *Plasmodium*; *Plasmodium falciparum*, *P. vivax, P. ovale* and *P. malariae* and transmitted by female anopheles mosquito vectors [1, 2]. Of these, *P. falciparum* and *P. vivax* are the most important [2]. Of the estimated 1 million malaria deaths worldwide, 90% occur in Africa, killing mostly young children [3-5], who account for 78% of all deaths [6]. In Africa, it accounts for 40% of public health expenditure and 25% of the household income [7].

The disease epidemics affect non-immune populations in many highland and semi-arid areas of the continent [8]. The control of malaria and its anopheline vectors in Africa is less successful because of the occurrence of drug resistant parasites and insecticide resistant vectors, change in the resting behaviour of mosquitoes (from indoor to outdoor) as a result of frequent indoor insecticide sprays, lack of efficient infrastructure, shortage of trained manpower, lack of equipment, lack of appropriate management, financial constraints and inability to integrate several methods of control [9].

The disease is one of the foremost health problem top ranking in the list of common communicable diseases in Ethiopia [10]. It is one of the leading causes of morbidity and mortality in Ethiopia [5]. Approximately 75% of Ethiopia's landmass is endemic for malaria, with malaria primarily associated with altitude and rainfall [11]. The Carter Centre [5] reported, about 55.7 million people in Ethiopia faced the risk of malaria, and approximately 80% of the 736 woredas (districts) in Ethiopia are considered malarious. Malaria transmission peaks bi-annually from September to December and April to May, coinciding with the major harvesting seasons [12,13]. This seasonality has serious consequences for the subsistence economy of Ethiopia's countryside and for the nation in general FMOH [14].

In the Southern Nations, Nationalities and Peoples' Region (SNNPR), Ethiopia about 65% of the population is living in malaria endemic areas [15]. In the region, malaria is the primary cause of outpatient and inpatient consultations and hospital deaths [16].

The identification of factors influencing malaria risk in households can guide targeted interventions [17]. Important risk factors such as housing type, house proximity to mosquito breeding sites or water drain, toilet facilities, and malaria preventive measures at the household level have been identified in different studies [18-20]. Additional factors such as number of bed nets per household, individual's age and residence altitude, and household wealth, peak monthly rainfall can affect malaria prevalence [21,22].

Malaria control is an increasingly important focus for the international body concerned with public health and disease control [23,24]. According to World Malaria Report [25], the combination of tools and methods to combat malaria now includes long-lasting insecticidal nets (LLIN) and artemisinin based combination therapy (ACT) supported by indoor residual spraying of insecticide (IRS), and intermittent preventive treatment in pregnancy, presents a new opportunity for large scale malaria control. Initial evidence indicated that the combination of mass distribution of LLIN for all children<5 years or all households and nationwide distribution of ACT in the public sector was associated with substantial declines of in-patient malaria cases and deaths in Rwanda and Ethiopia [26].

In light of the current malaria situation, the present study, therefore, aims to assess the prevalence and associated factors of malaria in Dilla town and the surrounding rural areas, Southern Ethiopia.

Methods

Study area and period

The study was conducted in Dilla town and the surrounding rural kebeles' health facilities, Gedeo Zone, Southern Nations Nationalities and Peoples' Region. Dilla is found in 360 km away from Addis Ababa, the capital of Ethiopia, which is situated at 1123.47 sq.kms at 6° 21'-6° 24' north latitude and 38° 17'-38° 20' east longitude. It is found in kola agro ecological zone with an altitude of 1400km above sea level and annual temperature ranging from 22°C-29°C. Dilla town is surrounded by different rural areas/kebeles such as Waleme, Chichu, Gola, Amba, Tumticha, Sisota, Chito etc, and, they have been included in Dilla zuria woreda. Dilla town administration has 03 sub cities (kifle ketemas), which includes 09 kebeles. It has the total population of 91,534 from these 18,307 households, 3570 under 1 child, 7606 under three children, 14,279 under five children. The two major malaria transmission periods in the area are from September to December and from April to June, with higher transmission during the former period [27].

The study was employed from the beginning of October to the end of December 2014, three months period.

Study design, population and inclusion criteria

An institution based cross-sectional study was carried out among subjects attending the health centers/facilities in Dilla town and rural areas from selected kebeles. Individual household members, who came to health centres, from both areas, for any kind of health service during the data collection period, were selected randomly. All individual members who were permanent residents in the randomly selected kebeles, above 18 years of old, and volunteer to participate in this study were included in the study for questionnaire survey of associated factors of malaria. For malaria prevalence study all individual members of the selected households except those who were on anti-malaria drugs for the past 7 days were included in the study.

Sample size determination, technique and procedure

Calculation of sample size (n) will be estimated using the single population proportion formula; we calculated the sample size for malaria parasite prevalence testing and associated factors assuming an expected prevalence of 3.9% from the study conducted in Hawassa, Ethiopia [28], 0.3 margin of error for 95% confidence interval (CI), 5% level of significance, design effect of 2, and 10% of contingency for non-response. Finally, samples of 352 individuals were estimated.

A stratified random sampling technique was used to select the kebeles/villages. By using a stratified random sampling technique each kebele, based on geographical location, were selected and then the required study subjects were identified systematically in both areas. Accordingly, three (3) kebeles were randomly selected from each area. Then, in both districts, rural (Chichu and Sisota) and urban (Haroressa) health facilities were selected. Finally, the randomly selected attendants from each health facility of sampled kebeles were selected, by taking every 4th attendant from random start on the health centres.

Data Collection Procedures

Malaria parasite microscopy

Individual participants, totally 350, who came to each health centres [Haroressa (Dilla town), Chichu and Sisota (surrounding area) health centres] for all kinds of services, were selected randomly for parasitological examination. Two laboratory technicians were recruited & provided with two days of training on the study protocol as well as recording formats.

A small blood volume (capillary blood from fingertip) was collected. Two blood slides each composed of thick and thin films, were taken from each participant by a medical laboratory technician according to the standard operating procedure (SOP) protocol and standards [29]. Slides were labeled and air-dried horizontally in a slide tray, and thin films were fixed with methanol after drying. Slides were stained with 3% Giemsa for 30-45 minutes at each health center laboratory unit [25]. Blood slides were read and cross-checked by senior laboratory technologists at the laboratory unit as, either negative for blood parasites, *P. falciparum* positive, *P. vivax* positive, or mixed infection with both *P. falciparum* and *P. vivax*. The staining technique and blood film examination was conducted according to a standard of WHO Protocols [30,31]. Then, parasite positivity was determined from thick smear and species identification was carried out from thin smear slide preparations. To ensure validity of the slide test, all positive slides and 10% of randomly selected negative slides were sent to the regional health bureau. In addition, the same sample was re-examined by a second independent Medical Laboratory Technologist. Any discordant results were reread later.

Questionnaire survey

The survey questionnaires were based on the malaria indicator survey household questionnaires, which were filled by the participants. Before going to the actual data collection, pretest of the questionnaire was done among 5% of the sample in nearby localities not involved in the actual data collection. A total of 4 data collectors, who had previous experience with malaria surveys, and 2 supervisors were involved after two days of intensive training. Moreover, the investigators were involved in the provision of training for data collectors and monitoring the overall data collection activities. The questionnaire was administered to volunteers by trained interviewers according to the time schedule of the participants.

Data analysis

The collected data was entered and analyzed by using computer program SPSS version 20. Frequencies, proportion and summary statistics were used to describe the study population in relation to relevant variables. Differences in proportions between Dilla town and surrounding rural cables as well as the differences between different malaria parasites were compared using chi-square tests and odds ratio (OR) together with their corresponding 95% confidence interval were computed. The results were written reorganizing, summarizing and quoting when needed.

Patients' management

Participants with malaria parasite positive were offered treatments according to national malaria guidelines; CoArtem® for *P. falciparum* infection and chloroquine for *P. vivax* [31].

Ethical considerations

Prior to the commencement of the study, ethical clearance was obtained from the ethical committee of College of Health Sciences and Medicine, Dilla University. After permission is obtained, support letters written by the University was submitted to all concerned bodies in the study sites. Prior to blood sample collection, the objective of the study and procedure of sample collection was explained to the study participants and/or parents/guardians/caregivers for study subjects of below 17 years of age. The written informed consent was also obtained from the participants and parents/guardians/ of children aged 17 years and younger.

Results

Socio-demographic characteristics of the respondents

In the present study, a total of 350 individuals were included with a response rate of 99.4%. One hundred twenty one (34.6%) of the participants were in the age group of 15-24 years while 198 (56.6%) of individuals were males and 152 (43.4%) of them were females (Table 1). The majority of the respondents were Gedeo in ethnicity with (63.7%). 56.6% of the study subjects were married and most (52.3%) of them had no formal education. Two hundred fifty three (72.3%) of the participants had family size of 5 and below persons per head (Table 1).

Variable/characteristics	Individual participants (N=350)	
Age of respondents	**Frequency**	**Percent**
<5	15	4.3
5-14	92	26.3
15-24	121	34.6
25-34	65	18.6
35-44	13	3.7
45-54	24	6.9
55	20	5.7
Sex of respondents		
Male	198	56.6
Female	152	43.4
Marital status		
Single	121	34.6
Married	198	56.6
Divorced	8	2.3
Widowed	20	5.7
Others	3	0.9
Ethnicity of respondents		
Gedeo	223	63.7
Amhara	58	16.6
Oromo	40	11.4
Others	29	8.3
Number of the members of household		
≤ 5	253	72.3
>5	97	27.7
Educational status		
Literate	167	47.7
Illiterate	183	52.3

Table 1: Socio-demographic characteristics of the respondents, Dilla town and the surrounding area, Ethiopia, from October-December, 2014.

Malaria prevalence in the study localities

A total of 350 study subjects were examined including 174 from the rural communities and 176 from Dilla town. Malaria positive individuals were identified from three kebeles of Dilla town (Haroresa, Haroke and Sessa kebeles) and three nearby rural kebeles, namely Chichu, Sisota and Chito kebeles. The overall prevalence of malaria infection in the study area was 16%. *Plasmodium vivax* accounted for 62.5% of infections, *Plasmodium falciparum* for 26.8% and 10.7% for mixed infection (*P. vivax* and *P. falciparum*). The malaria parasite prevalence was differed between Dilla town 26(46.4%) and rural kebeles 30(53.6%), but no significant difference (P=0.304) (Table 2, Figure 1).

Distribution of malaria parasites with age and gender of the study subjects

Of the total (16%) malaria parasites' prevalence, 58.9% and 41.1% of the parasites occurred in males and females, respectively. The greatest malaria prevalence was seen among 15-24 years of age with 35.7%. The age and gender wise distribution of malaria parasites in the study area is shown below (Table 3).

Malaria parasite prevalence with regard to the housing condition of the participants

It is observed that significant respondents were positive with malaria who were living in houses' wall is mud bricks than those who lived in a house with other materials of the wall ($p<0.05$). Prevalence of malaria has not showed a significant association with regard to the housing condition of the roof (p-value>0.05) (Table 4).

Locality	No. Examined	Malaria Positive N(%)				P-value
		P. falciparum N (%)	*P. vivax* N (%)	Mixed infection (Pf and Pv) N (%)	Total positive N (%)	
Dilla town	176	9 (34.6)	16 (61.5)	1 (3.8)	26(46.4)	0.304
Dilla zuria	174	6 (20.0)	19 (63.3)	5 (16.7)	30 (53.6)	
Total prevalence	350	15 (26.8)	35 (62.5)	6 (10.7)	56(16.0)	

Table 2: Comparison of malaria parasitological prevalence in the study localities, from October-December, 2014.

Age	No. Examined	BF-ve N (%)	BF +ve N (%)	Female cases (n=23/)/41.1%			Male cases (n=33)/ 58.9%		
				Pf	Pv	Mixed	Pf	Pv	Mixed
<5	15	11 (3.7)	4 (7.1)	1	1	0	0	2	0
5-14	92	77 (26.2)	15 (26.8)	2	4	0	3	5	1
15-24	121	101 (34.4)	20 (35.7)	0	6	2	3	9	0
25-34	65	55 (18.7)	10 (17.8)	0	1	1	3	3	2
35-44	13	11 (3.7)	2 (3.6)	0	2	0	0	0	0
45-54	24	20 (6.8)	4 (7.1)	0	2	0	2	0	0
>55	20	19 (6.5)	1 (1.8)	1	0	0	0	0	0
Total	**350**	**294 (100)**	**56 (16)**	**4**	**16**	**3**	**11**	**19**	**3**

Table 3: Age and gender wise prevalence of malaria parasites, Dilla town and the surrounding area, Ethiopia, from October-December 2014.

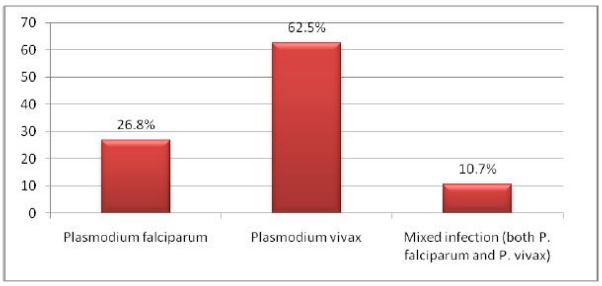

Figure 1: Percentage of malaria infection by parasite species, in the study areas, from October-December, 2014.

Logistic regression analysis results

The proportion of individuals with microscopically confirmed malaria in which their house has not been sprayed with insecticide chemicals (Proxus, Bifenthrin and/or Deltamethrine) in the past 6 months were twofold higher compared to those individuals getting this particular prevention measure [OR=2.45, 95% CI: 2.20-3.99)] (P-value<0.05). It is indicated that approximately twofold increased prevalence of malaria was observed in individuals' who have been living in the nearby stagnant water than those who were far away from these risky areas [OR=2.01, 95% CI (1.50-3.85)] (p-value<0.05). Study subjects who did not use insecticide treated nets were found 0.2 times less likely to get malaria [OR=0.16 95% CI=(0.08-0.29)] (p-value<0.05). Otherwise, there was no significant difference with other socio-demographic factors (Table 5).

Discussions

The overall microscopic prevalence of malaria infection in the current study was 16%, with higher prevalence in the rural communities (p=0.304). According to Gedeo Zone Health office report, reduction of malaria, particularly for the last 3 years is shown [27]. The present result is consistent with the study conducted among patients attending public health facilities in Maputo City, Mozambique with 15.7% of prevalence [32]; result from Pakistan, Lal Qilla visited to health care center 17.3% [33] and from Hadhramout, Yemen [34] with 18.8%. This result was higher than reports from Kemisie, Ethiopia [35], Butajira, Ethiopia [36], Bangladesh [37], and Eritrea [38] with 5.3%, 0.93%, 3.97% and 2.2% respectively. In contrary, it is less than that reported in Kersa Woreda Jimma 43.8% [39], Hallaba, Ethiopia [40] with 82.8% and Nigeria by 39.5% [41]. The observed difference might be due to the seasonality of malaria, the different control measures in the current study area and the study design.

This study showed that malaria prevalence in rural kebeles was more (53.6%) than in the town (46.4%) indicating that a less effective malaria control measures were applied in the rural areas. This is similar to the study conducted in Maputo City, Mozambique with the higher prevalence rate in the rural areas [32].

The species wise distribution shows Plasmodium vivax was the predominant species, accounting for 62.5% (n=35), followed by

Plasmodium falciparum 26.8% (n=15) and mixed infection with both *P. vivax* and *P. falciparum* 10.7% (n=6). This is in line with the studies conducted in Gojjam, Northern Ethiopia [42] and in Hallaba, Southern Ethiopia [40]. But this result is contradicting with the national prevalence of *Plasmodium falciparum* and *Plasmodium vivax*, which is 65-75% and 25-35% respectively [5]. In addition, studies conducted in hospitals, Islamabad, Pakistan [43] and Hadhramout, Yemen [34] are not supporting this study reporting a higher prevalence of *Plasmodium falciparum* infection. The deviation between the finding of this study and the national figure of epidemic regarding *Plasmodium vivax* along with *Plasmodium falciparum* might be due to relapsing regarding *Plasmodium vivax*. As outlined by, the information obtained from communicable diseases prevention and control office of Gedeo zone, preventive and curative actions were taken particularly when there is *Plasmodium falciparum* epidemic. A more than two-fold increase in the rate of drug resistance has been reported in south-central Ethiopia, close to the study area [44]. Thus, chloroquine resistant vivax malaria may have accounted for the dominance of vivax observed in the curremt study.

Characteristics	**Frequency N=56**	**Percent (%)**	**P-value**
Main material in walls			0.027
Mud blocks/bricks	31	55.4	
Cement blocks/bricks	14	25.0	
Sticks	4	7.1	
Wood planks	6	10.7	
Corrugated metals	1	1.8	
Main material in roof			0.47
Thatch	11	19.6	
Stick and mud	32	57.1	
Corrugated iron	9	16.1	
Others	4	7.1	

Table 4: Prevalence of malaria parasites with regard to the housing condition of the study subjects, Dilla town and the surrounding area, Ethiopia, October-December 2014.

Factor	**Microscopically confirmed malaria (N=350)**		**OR (95% CI)**	**p-value**
	Yes=56	**No=294**		
Sex of the respondents Female Male	23 33	129 165	1.12 (0.63, 2.00) 1.0	0.68
Residence Dilla town Dilla zuria	26 30	150 144	1.20 (0.68, 2.13) 1.0	0.52
Presence of stagnant water in the compound Yes No	42 14	176 118	2.01, (1.50-3.85) 1.0	0.03
Bed net availability and usage Yes No	25 31	48 246	0.16, (0.08-0.29) 1.0	0.001
Presence of chemical spray Yes No	46 10	267 26	2.45, (2.20-3.99) 1.0	0.02
Household family size <5	35 21	218 76	1.72, (0.94-3.14)	0.08

>5				

Table 5: Logistic regression analysis for malaria parasites' prevalence showing the OR for some selected socio-demographic variables and their 95% confidence intervals, Dilla town and the surrounding area, from October-December 2014.

This study also showed that malaria parasite was higher in males (58.9%) than in female (41.1%) subjects. This is in agreement with the findings of Ayele et al. [20], Ferede et al. [45] and Abebe et al. [46] who reported infection rate to be higher among males in Northwest Ethiopia but differs from the findings of Okonko et al. [1] and Girum Tefera [40] in similar studies, Nigeria and Ethiopia respectively, where female subjects were more infected.

The highest prevalence of malaria found in the age groups of 15-24, the reason behind this increased prevalence of malaria in this specific age group is attributed to relatively high outdoor exposure to the mosquito vector bites. This is consistent with the findings reported in Kersa Woreda, Jimma [39] and Hadhramout, Yemen indicated a higher number of positive smears observed in adults (>15 years of age) as compared to children [34]. But this finding was disagreeing with the finding of Ferede et al. [45] with 5-14 years old groups were most affected age groups. The other socio-demographic factor which showed a household size<5 that revealed a high percentage of malaria cases compared to family size above 5 but no significant difference (OR=1.72, 95% CI: 0.94-3.14), (p>0.05).

Living in the nearby stagnant water was also identified as a risk factor. The significantly higher parasite rate found among the individuals having stagnant water in their compound (OR=2.01, 95% CI: 1.50-3.85), p=0.03. It can be explained from the fact that they are more exposed to mosquito bites, because these areas are suitable for breeding of mosquitoes around their homes. More so, participants whose house has not been sprayed with insecticide in the past 6 months are two times more likely to get malaria infection (OR=2.45, 95% CI: 2.20-3.99), p=0.02. This is similar with the study done in Maputo City, Mozambique [32]. Individuals having and using insecticide treated nets were 0.2 times less likely to get malaria parasites than those of not having adequate bed nets (OR=0.16, 95% CI: 0.08-0.29), (p<0.05). This finding is in agreement with the reports of Nahum et al. [47] with (OR=0.77; 95% CI =0.61-0.97; P<0.026).

Interaction between malaria parasites and main construction material of the room's wall is presented. From the result, it is clearly seen that respondents' infection with malaria was significantly higher when the wall of the house was mud blocks/bricks (p<0.05). This is similar with some of the findings from previous reports [20,38]. This is because it is most suited for porous surfaces such as brick and mud walls for residence of mosquitoes. Malaria prevalence was found to be higher among respondents living in stick and mud roofs but no significant association.

Conclusions and Recommendations

Based on the finding of this study, the following conclusions are drawn: The finding revealed that that most of the infected participants were from the surrounding rural area with high prevalence of Plasmodium vivax. The study indicated that there is association between prevalence of malaria parasites and type of housing construction, bed net ownership, presence of mosquito breeding areas and chemical spray of the respondents' houses.

Efforts must be made to expand and sustain the combined availability and application of ITNs with source reduction measures both in Dilla town and the rural localities. Public health policies aimed at increasing integrated approach of malaria control should continue to support programs, particularly in rural areas, including a system to support the provision of insecticide treated bed nets (ITNs), indoor residual spraying of insecticide and intermittent preventive antimalarial treatment.

Competing Interests

The authors declare that they have no competing interests.

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