Original article

Malaria in Addis Ababa and its environs: assessment of magnitude and distribution

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Abstract

Background: Malaria is one of the major public health problems in Ethiopia. Frequent epidemics and its appearance in highland areas previously known to be beyond malaria transmission upper limit are becoming common in the country.

Objectives: The objective of the study was to review and document the situation of malaria in Addis Ababa.

Methods: Records on cases of malaria seen at outpatient departments of 20 health centers in the six administrative zones of Addis Ababa were reviewed. An epidemic report compiled relatively recently was as well used as a source of additional information.

Results: Rise in the number of malaria cases treated at outpatient departments in Addis Ababa was noted from 1996 on wards. In one of the administrative Zones of Addis Ababa, Akaki and its surroundings, an outbreak of malaria was reported during 1998/9. More than three times increment of primary clinical cases of malaria was recorded during the peak of this epidemic.

Conclusion: It is believed that malaria is one of the causes of morbidity congesting health services in Addis Ababa City Administration. The epidemic at the peripheral part of the City, Akaki and its environs in 1998/9 is believed to be associated with the climate change during this period. [*Ethiop.J.Health Dev.* 2002;16(2):147-155]

Introduction

In spite of intensive control activities undertaken in the past four decades, malaria remains to be one of the major public health problems in Ethiopia. It has been a cause of morbidity and mortality as well as low productivity in the country since early days (1). Previously, the disease was known to occur below elevation of 2000m, except during epidemics (2,3,4). An estimated 6 million clinical cases occur annually (5). It is also considered to have influenced population dynamics and productivity in the country. The interest of the country to undertake development and agricultural projects in fertile lowland areas along big rivers was repeatedly discouraged due to malaria (6,7,8). It is believed that high altitude areas are salubrious from the time of European settlers in most parts of African countries. For instance, in Ethiopia as a result of fear of malaria in fertile lowland areas, overcrowding and ecological degradation resulted at high altitude areas (7). Moreover, the development projects, and resettlement and villegization policy of the previous regime to overcome the ecological upheaval and famine moved more than half-of-a million of non-immune highlanders to fertile lowland areas in the mid-1980s. Unfortunately, this resulted in an abrupt rise of malaria and change in its epidemiology in the country. The case of Arba Minch and Pawie, south and west lowlands of Ethiopia, is worth mentioning (8). Similarly, in the 1990s, compounded with the advance of the civil war, ecological changes, appearance and widespread resistance of the malaria vectors to insecticides and parasites to

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anti-malarial drugs resulted in outbreaks of malaria in the country. The decentralization of the vertical Malaria Control Program and its integration with general health services without prior preparation as well is believed to be a contributor in the deterioration of the control activities and appearance of outbreak (9). In addition, recent reports have shown that global warming is becoming one of the major causes for encroachment and occurrence of malaria epidemics in high altitude areas of Africa, including Ethiopia (10,11,12). As some fifty percent of the high land mass in Africa is reckoned to be in Ethiopia (13), the country is considered to be prone to highland fringe malaria. Evidences have also shown the rise of malaria cases in highland areas of the country from the early 1990s (11).

There were early studies that recorded the occurrence of suspected locally contracted malaria cases at Addis Ababa around areas with altitude of 2470m, Filwuha, hot spring, (14, 15, 16). Moreover, the latter authors have identified female *An. gambiae* near the Railway Station in the lower part of the City near Filwuha. It was suggested then that this vector species may extend its upward range and reach suitable breeding places in the warm springs of the Filwuha area of Addis Ababa from Akaki Valley as a potential site to support the vector species, *An. gambiae* (15). They have also indicated the breeding of *An. gambiae* during the cessation of the rainy season, from mid-September to early November, in the bed of the Kebena River. In addition, the occurrence of numerous malaria cases in Akaki, and the villages around the artificial lakes (locally known as Aba Samuel) and the vicinity was confirmed (16). On the other hand, the latter sites were known to have been seriously stricken with the devastating malaria epidemics of 1958 (3). In this regard, Akaki Town was believed to have been rescued from that epidemic as a result of the intensive indoor residual spray using DDT since it was one of the areas included in the then malaria control pilot projects. Nevertheless, malaria outbreak was reported in Akaki Town and its adjacent localities in 1988/9 (Aklilu Siyoum personal communication, 1998). Malaria vector control activities and treatment of cases in Akaki Town were earlier carried out by the Debre-Zeit Malaria Sector, under the Oromia Health Bureau. With changes in the administrative boundaries of Addis Ababa, recently, i. e., extension to Akaki Town and to some of the surrounding rural areas, the control activities by the latter region were discontinued.

In general, recently, multitudes of development and construction projects are underway in Addis Ababa, progressing to rural malaria endemic adjacent areas. Consequently, these human activities could create suitable breeding sites for, *An. arabiensis*, the principal vector of malaria in the country.

Thus, more information is required on the epidemiology of highland malaria such as Addis Ababa and its surroundings. Therefore, the purpose of this paper is to assess the status of malaria in/around Addis Ababa, describe the causes of malaria outbreaks and control measures conducted during 1998/9. The improvement of malaria surveillance and implementation of early warning system at different levels is also discussed.

Methods

Addis Ababa is located on the Shewan Plateau, which is a physiographic region in the center of Ethiopia. The part of the Shewan Plateau where Addis Ababa is located ranges in height from about 2333m at Addis Ababa Bole Airport, the southern part of the city, to approximately 2979m on Entoto Mountains, which form the northern boundary of the City. To the west of the City, Mt. Wachacha rises approximately to a height of 3353m, to the South are found a number of hills of smaller heights than Wachacha; and to the Southeast Mt. Yerer rises to the height of Entoto.

Monthly morbidity data on total cases and malaria cases treated at outpatient departments in health facilities in Addis Ababa was obtained from the City Administration Health Bureau. The health facilities comprised of 20 health centers in the six administrative zones of the City. Malaria cases were diagnosed

either with microscopy or on clinical impression. An effort was made to see the relative importance of malaria and all new cases. For the purpose of this paper, new cases are illnesses of all types excluding repeated cases. Quarterly proportion of malaria cases was determined relative to all new cases in the recent five years. To compare real changes in malaria cases and all new cases at different periods of the epidemics, the ratio of cases was computed using the method applied in Kenya (17).

Results

A total of 28,906 malaria cases were treated at different health facilities in Addis Ababa City from 1993 to 1999 (Table 1). An increment of malaria cases was observed from 1996 on wards. Of those years, annual rises of malaria cases become more prominent from 1996 onwards. It peaked in 1998,followed by a slight decline in 1999. All age groups were affected with relatively more cases in the age groups 15 years and above. Moreover, a sizeable number of infants and children aged between 1 and 4 years were also treated for malaria.

Table 1: **Age distribution of malaria cases treated at different health facilities in Addis Ababa City between 1993 and 1999**

Year	Age group				Total (%)
	<1	1 to 4	5 to 14	15+	
1993	1	2	44	72	119 (0.41)
1994	0	2	17	78	97 (0.34)
1995	1	1	31	147	180 (0.62)
1996	7	112	418	4858	5395 (18.66)
1997	38	243	821	6330	7432 (25.71)
1998	58	220	1116	8266	9660 (33.42)
1999	79	155	1338	4451	6023 (20.84)
Total (%)	184 (0.63)	735 (2.54)	3785 (13.1)	24202 (83.73)	28906 (100)

Source: Department of planning and programming service, Addis Ababa City Adm. Health Bureau

Of the total malaria cases, 23,323 (80.7%) were microscopically confirmed (Table 2). More than 62% of the cases were due to *P. vivax*, followed by *P. falciparum* (32.5%) and rarely *P. malariae* (5.2%). *Plasmodium vivax* has increased by more than two folds both in 1997 and 1998; while, about four folds in 1999 compared to *P. falciparum.*

A total of 6,257 malaria cases were diagnosed from 1996 to 2000 at Akaki Health Center alone (Table 3). These cases were from Akaki, a suburb and part of Addis Ababa and its surroundings. Of these cases, the majority appeared in the years 1997 and 1998 with gradual decline. The majority of the cases appear to be in the age groups 15 years and above, more than three-fourths, followed by more than one-fifth of them in the 5 to 14 years and the rest being in below five years, including children and infants.

Table 2: **Microscopically confirmed malaria cases in Health Centers in Addis Ababa City from 1993 to 1999**

Year	Species distribution			Total (%)
	P. vivax	*P. falciparum*	*P. malariae*	
1993	2	1	4	7 (0.03)
1994	2	2	0	4 (0.02)
1995	1	2	0	3 (0.01)
1996	2258	2462	189	4909 (21.04)
1997	4326	1832	469	6627 (28.4)
1998	4973	2411	520	7904 (33.9)
1999	2966	859	44	3869 (16.6)
Total (%)	14528 (62.3)	7569 (32.5)	1226 (5.2)	23323 (100.0)

Source: Dept. of planning and programming service, Addis Ababa, City Adm. Health Bureau

Table 3: **Age distribution of malaria cases treated at Akaki Health center between 1996 and 2000**

Year	Age groups				Total (%)
	<1	1 to 4	5 to 14	15+	
1996*	0	0	117	419	536 (8.7)
1997	4	8	354	1090	1456 (23.6)
1998	2	5	604	2117	2728 (44.3)
1999	3	12	156	454	625 (10.5)
2000*	3	50	181	578	812 (13.2)
Total (%)	12 (0.2)	75 (1.21)	1412 (22.93)	4658 (75.7)	6157 (100.0)

* Data not obtained from January to March 1996 and December 2000
* Source: Zone 6 Health Department, Addis Ababa

Of the total 6,157 clinical malaria cases seen at Akaki Health Center, 3,046 (48.7%) were microscopically confirmed (Table 4). About 72% of the cases were due to *P. vivax*, followed by *P. falciparum* (16%) and *P. malariae* (12%). *Plasmodium vivax* has increased by four folds in 1997 and eight folds in 1998 compared to *P. falciparum*. This species reached its peak during 1998.

Plasmodium falciparum has shown abrupt reduction in 1999 and 2000, *P. malariae* being totally absent in these years. *Plasmodium ovale* was not diagnosed in health service units of the area. No mixed infection was also reported.

The five-year trend in the Out Patient Department at Akaki Health Center for all new cases and malaria cases is shown in Table 5. Quarterly comparison of proportion of malaria cases in relation to all new cases shows its rise in both the 3rd quarter of 1997 and 4th quarter of 1998. The highest proportion of malaria cases were seen in the 4th quarters of both 1997 and 1998.

Table 4: **Microscopieally confirmed malaria cases at Akaki Health Center between 1996 and 2000, Akaki Town**

Year	Species			Total (%)
	P. vivax	*P. falciparum*	*P. malariae*	
1996	203	98	2	303 (10)
1997	426	112	165	703 (23)
1998	1072	132	193	1397 (45.9)
1999	247	69	0	316 (10.4)
2000	237	90	0	327 (10.7)
Total (%)	2185 (72)	501 (16)	360 (12)	3046 (100.0)

Source: Zone 6 Health Department, Addis Ababa

The trend in out patient malarial cases seen at Akaki Health Center before and after the epidemic is shown below (Table 6). Patients with primary clinical diagnosis of malaria increased by three times at the peak of the epidemic. Other illnesses remained the same before and during the epidemic as shown by the before-after ratios in Table 6.

Nine urban Kebeles, five in Akaki (01,02,04,06 and 07), and four in Kaliti (03,08,09 and 10) and one Farmers' Association (Sallo Gora) were affected with the epidemic of 1998/9. The then epidemic appears to involve a larger area in the outskirt of Addis Ababa, including localities in the Akaki River Valley, extending to parts of Kaliti. As for instance the sites implicated for contributing cases in Kaliti comprise of what is commonly known "Meteleya" (shelter of displaced people from Eritrea in the mid 1990s), Saris Abo and Hana Mariam. Cases were as well reckoned to be originating from other peripheral sites of Addis Ababa, namely, Bole Bulbula.

Integrated epidemic control measures such as mass treatment of febrile cases and vector control were conducted. In addition, health education was given to the inhabitants. The activities conducted during the peak of this epidemic, October through November 1998,

Table 5: **Five years trend in out patient consultations of all new cases and malaria cases at Akaki Health center, 1996 to 2000.**

Year	Cases	Quarters				Total
		1st (Jan-Mar)	2nd (Apr-Jun)	3rd (Jul-Sep)	4th (Oct-Dec)	
1996	a	0	2775	3637	3913	10325
	b(%)	0	47 (1.7)	53 (1.5)	402(10.3)	502(4.9)
	c	0	17	14	201	
1997	a	3753	3869	3775	5241	16638
	b(%)	102 (2.7)	67 (1.7)	253 (6.7)	1059 (20.2)	1481(9)
	c	34	22	84	353	
1998	a	5238	5228	5339	4153	19958
	b(%)	591 (11.3)	600(11.5)	734 (13.7)	824 (19.8)	2749(13.8)
	c	197	200	245	275	
1999	a	3089	2610	2792	3091	11582
	b(%)	299 (9.7)	134 (5.1)	134 (4.8)	149(4.8)	716(6.2)
	c	100	45	45	50	
2000	a	2881	3227	3459	4758	14325
	b(%)	172(6)	102 (3.2)	282 (8.2)	356(7.5)	912(6.4)
	c	57	34	94	119	

Source: Department of Planning and Programming Service, Addis Ababa City Adm. Health Bureau
(a=all new cases, b(%)=malaria cases, c=monthly average malaria cases)

Table 6: **Monthly average outpatient consultations before, during and after epidemic at Akaki Health Center**

Patients	Period of epidemic		
	Before	During	After
Malaria cases	47	440	310
Ratio	3.1	9.4	6.6
All new cases	1266	2068	1587
Ratio	1.7	1.6	1.3

are presented in Table 7 below. The vector control measures conducted were indoor residual sprays and larviciding using DDT and Temophos, respectively. Temophos is an organo-phosphorus compound, highly active against mosquito larvae and other aquatic insects, while its toxicity to fish, birds, mammals and humans is very low. House spray was done in 8 localities with 7,000 unit structures with 1,332.3 Kg of DDT to protect 15,244 inhabitants. Similarly, total areas of 3,040m^2 mosquito breeding sites located in 7 localities were sprayed with 776 ml of Temophos.

Mass drug administration was an emergency control method implemented to contain the epidemic. To accomplish all the above mentioned activities it coasted the Zone 6 Health Department a total of 12,830 ETB (1 USD≅8.56 ETB). Community leaders and elders from Akaki Town mentioned that the area was known to be free of malaria in the past, although, a serious malaria epidemic has occurred in 1998/9 and killed many people in localized areas, "Megala Sefer", areas south of the Railway Line. In spite of the reported epidemic, mortality data during the epidemic was not available from health institutions in the area.

Table 7: E**pidemic control measures undertaken during October/November 1998 in Akaki Town and its surroundings**

Indoor residual spray	
Unit structures	7000
Total localities sprayed	8
Population protected	15244
DDT (75%) used (kg)	1332.3
Larviciding	
Total localities sprayed	7
Areas covered (m^2)	31040
Temophos used (ml)	776

Source: Zone 6 Health Department Epidemic Report, Addis Ababa

Discussions

A considerable number of malaria cases were described in Addis Ababa in the defined period. Thus, malaria is one of the major causes of morbidity, congesting health services. The increase in malaria prevalence in the mid and late 1990s is in agreement with the overall pattern of the disease in the country

(Unpublished annual report of Malaria Control Unit, MOH, 2000). Furthermore, case build-up was detected in the years 1997 and 1998.

Obviously, most of the malaria cases treated are considered to be internally imported and referred cases from malaria endemic regions. Residents and visitors from malaria endemic areas such as Modjo, Debre-Zeit, Nazareth, Sodere (resort and recreation centers) and their surroundings might visit these health services either in seeking better services or as primary cases.

Nevertheless, the presence of autochthonous malaria transmission is suspected at some localities with favorable conditions for vector breeding. It is interesting to note that malaria cases were also seen in age groups less than 5 years, including infants. In stable communities, this age group is less mobile; consequently autochthonous malaria transmission in at least peripherally located areas is suspected. In agreement with this, an early study confirmed the occurrence of indigenous malaria transmission in Addis Ababa around the area locally known as Fil-Wuha, hot spring (14).

On the other hand, regarding the species composition, *P. vivax* is the commonest species followed by *P. falciparum* and *P. malariae*. The former species outnumbers *P. falciparum* by two folds in age groups 15 years and above. *Plasmodium malariae* was the least abundant compared to other species. This is in accordance with its national figure (5).

An early study has documented the predominance of *P. vivax* at heights of 1500m. a. s. l. and on the western slopes as well as eastern parts of the country (18). The highland areas of Ethiopia unlike the lowland areas with tropical climate, favor the wide distribution of *P. vivax*. The epidemiological importance of *P. vivax* in highland and urban areas during dry seasons, owing to its short period of transmission was also noted (14). In contrast to this report, *P. falciparum* was the predominant species in many places (3, 6, 20,21). A previous study has shown that resettlement and agricultural activities brought about a shift in parasite distribution elsewhere (22). Intensive control measures might have also played a plausible importance in this regard.

Moreover, detection of *P. malariae* might be attributed to either species misdiagnosis or internally imported cases. The presence of this species in highland areas of the country is not yet documented. Evidently, early studies have shown the presence of *P. malariae* in south and southwest, and in the Awash Valley (21,23). However, the occurrences of *P. ovale* infections were reported to be localized to southwestern lowland areas (6,21).

Health service reports from outpatient consultation at Akaki Health Center from 1996 to 2000 also show that malaria was one of the major causes of illnesses in Akaki Town and its surroundings. The highest malaria cases were seen during 1998/9. It was an epidemic year in most parts of the country.

The outbreak of malaria during 1998/9 in Akaki and its environs is in harmony with the malaria situation in many areas of the country. The Ministry of Health has received many outbreak calls concentrated to highland areas during those years (5). The sharp rise in malaria cases was, however, not parallel to other epidemic sites, since outbreaks in other places were arrested with the application of different control measures. Similar actions were undertaken to contain devastating epidemics within two weeks in Kenya (17).

Moreover, regarding the cause of the epidemic, no unusual conditions such as population influx and any other cases were observed in the area. No history of drug resistance was recorded. The epidemic control report of Zone Six Health Department revealed that Chloroquine was efficacious to combat the epidemic for both species (unpublished report, 1998).

Nevertheless, the climatic changes are believed to be conducive for the occurrence of malaria epidemics in high altitude areas. Highland fringe areas such as Addis Ababa

and its environs are prone to slight changes in climate that subsequently influence malaria transmission. Variations in climatic factors such as temperature and rainfall noted by the three meteorological stations of Addis Ababa, viz. the Geophysical Observatory Center (Science Faculty, Addis Ababa University), Addis Ababa Observatory Center, (near Tikur Anbessa Hospital), and Addis Ababa Bole Airport Observatory are worth mentioning (24).

On the other hand, there is enough evidence for the positive effect of climate change in enhancing the distribution and importance of malaria in higher altitudes adjacent to malaria endemic areas (10, 11). The previous studies have also confirmed the major role of climatic changes in malaria epidemics in Ethiopia (3, 27).

Similarly, a rise in minimum temperature anomalies by 0.5 and 0.6^{o}C in 1997 and 1998, respectively, relative to 1995 to 2000 was recorded at Addis Ababa Bole Air Port Observatory (25). With this background, it was suggested that malaria epidemics in Akaki and its environs in 1998/9 was partly due to these climatic changes.

In harmony with our observation, a previous study in Rwanda has also indicated the association of rise in minimum temperature with the increase of malaria transmission (20). Other related works already cited showing the positive effects of climate change on the distribution and incidence of malaria are more pronounced at the borders of malaria endemic areas and higher altitude within malaria endemic localities (10, 11). This is also believed to be equally true for the occurrence and flare up of malaria at higher altitudes of Ethiopia (3,23).

Many highland areas of different African countries such as in Uganda (28) and Kenya (29) were affected with malaria epidemics in the late 1990s, believed to be resulting from climatic changes during the same period. The year 1998 was an El Niño year known to be the warmest year of the century (30). It was also distinguished with flooding and rise of vector-borne diseases including malaria.

Human resource development is required to strengthen diagnosis and to improve treatment of malaria in areas where its diagnosis could be overlooked. Highland malaria is becoming common in high altitude areas as a result of ecological alteration and climatic changes. Cognizant of the prevailing threats from malaria, strengthening of disease surveillance systems and implementation of early warning mechanism to detect malaria outbreaks in vulnerable areas such as Akaki and its environs is deemed necessary and highly recommended.

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