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Full Length Research Paper

Assessment of malaria as public health problem in Finchaa Sugar Factory based on clinical records and parasitological surveys, western Ethiopia

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An assessment of the malaria prevalence and some of its risk factors was conducted in the Finchaa Sugar Factory estate, western Ethiopia, based on analysis of retrospective data from the health center, a cross-sectional survey using blood slides and a questionnaire. Over the period 2001 to 2005 average prevalence among suspected patients at the health centre was 30.9%. Examination of thick and thin blood films from a random sample of 700 individuals from 7 villages revealed infection rates of 1.4% in November 2005 and 3.9% in April/May 2006. Out of 37 malaria positives, more than half was due to *Plasmodium vivax* and the rest was *Plasmodium falciparum*. The study detected focal variation of prevalence associated with location of the village, presence of pools and socio-economic circumstances. Awareness of malaria transmission and control was generally low. Malaria is a year-round public health problem in Finchaa, possibly perpetuated by permanent water bodies, high influx of migrant laborers and reduced effectiveness of current control measures.

Key words: Malaria, irrigation, *Plasmodium falciparum*, *Plasmodium vivax*, public health, Ethiopia.

INTRODUCTION

Malaria is an important public health problem in Ethiopia, with some 5 to 6 million clinical malaria cases and over 600,000 confirmed cases reported from health facilities in non-epidemic years (FMOH, 2005). In 2002/03 the disease has been reported as the first cause of morbidity and mortality accounting for 15.5% outpatient consultations, 20.4% admissions and 27% in-patient deaths (FMOH, 2004). Fertile lowlands and major river valleys of Ethiopia have not been fully inhabited and developed largely due to high malaria transmission in the areas. Hence the population has largely settled on the highlands which has caused over-population, ecological degradation, reduced productivity and led to famine and poverty (Gebre-Mariam et al., 1988). Irrigation projects in Ethiopia aimed at exploiting the potential of the fertile river valleys have contributed to increased malaria transmission (Alemayehu et al., 1998; Haile-Meskal and Kloos, 1989). As in other countries (Keiser et al., 2005), the importance of surface water management in malaria transmission in Ethiopia has been demonstrated in various regions (Ghebreyesus et al., 1999; Yohannes et al., 2005). Others pointed at the combination of the construction of large irrigation schemes, establishment of state farms and extensive migrant labor and resettlement population movements in the country all influencing the prevalence, severity, and distribution of malaria (Deressa et al., 2006; Gebre-Mariam et al., 1988). The Finchaa Sugar Factory (FSF) and its estate in west-central Ethiopia is such a large state farm with an irrigation system, associated agro-industrial activities and high population influx. The area has significant prevalence of malaria and other parasitic diseases, with 28% for *Ascaris lumbricoides,* 26% for *Schistosoma mansoni* and 20% for hookworms (Birrie et al., 1997). This study was initiated in order to investigate the extent of malaria

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Table 1. The description of the study population in FSF during Nov. 2005 and April/May 2006 (N=1400), East Wellega, Ethiopia.

Village	Total household No. (%)	Sampled household No. (%)	Total population No. (%)	Sampled population No.	
				Male (%)	Female (%)
A	211(6.3)	9(6.4)	1048(5.7)	44(6.7)	34(4.6)
B	176(5.3)	7(5)	880(4.8)	28(4.2)	40(5.4)
C	182(5.4)	8(5.7)	906(4.9)	26(3.9)	44(6.0)
D	168(5)	7(5)	840(4.6)	28(4.2)	36(4.9)
E	189(5.6)	8(5.7)	946(5.2)	42(6.3)	30(4.0)
Agamsa	1149(34.2)	48(34.3)	6594(35.9)	238(36.0)	264(35.8)
Kuyisa	1284(38.2)	53(37.9)	7146(38.9)	256(38.7)	290(39.3)
Total	3359(100.0)	140(4.2)	18360 (100.0)	662(3.6)	738(4.0)

transmission and some of its determinants in Finchaa.

MATERIALS AND METHODS

The study was carried out in Finchaa Sugar Factory (FSF) estate, some 330 km west of Addis Ababa, between November 2005 and May 2006. The estate covers more than 800 hectares of warm and moist fertile lowland area with sprinkler-irrigated sugar cane. In Zimbabwe this type of irrigation contributed to increased risk for malaria transmission (Chimbari et al., 2004). Mean annual precipitation is 1485 mm, with mean maximum and minimum temperatures of 30.6 and 14.5°C, respectively and relative humidity of 62%, facilitating year-round malaria transmission (Abeku et al., 2004; Malakooti et al., 1998; Temu et al., 1998; Zucker, 1996). The main rainy season is from June to September and the secondary rainy season in March and April.

Secondary data on microscopically confirmed malaria case rates between 2001 and 2005 were collected from the FSF health center and compared to primary data from a new parasitological study. Two community based cross-sectional household surveys were conducted in the estate's resident villages A, B, C, D, E, and two geographically adjacent villages Agamsa and Kuyisa during the two peak malaria transmission seasons, from 16 to 22 November 2005 (first survey) and from 26 April to 4 May 2006 (second survey).

Calculation of sample size (n) was done using the formula for estimating single proportion at 95% CI level (Zά/2=1.96). However, since there were no previous or pilot malaria studies conducted in the area, 50%: 50% was assumed for prevalence (P). A minimum of 600 samples (n) was generated using 4% marginal error (d) as shown below. Therefore, once the minimum number of sample was obtained, by adding 16.5% contingency, a total of 700 study subjects were enrolled as shown in Table 1.

Agamsa and villages A through D generally consisted of residential, good quality houses especially built for the FSF employees, while village E had more temporary shelters for daily laborers and Kuyisa was a village constructed by the inhabitants themselves. According to the sugar factory the total number of households was 3,359 and the population approximately 18,360 people. A total of 700 individuals from 140 households, proportionally distributed over the seven villages, were sampled twice. Blood smears were collected by finger prick from all available and consenting members in the selected households. A questionnaire was administered to household heads on demographic information educational background, and housing type. Thick and thin finger prick blood samples were collected by local technicians and supervisors. Thin blood films were fixed in methanol for 30 s and smears were stained with 3% Giemsa solution for 30 min according to standard WHO protocols (Cheesbrough, 1987; Garcia, 2001). Microscopic examination of the blood slides for presence and identification of parasite was done at the factory's health center under 1000x oil immersion objective.

Ethical clearance for the study was provided under the umbrella of the Addis Ababa University agreement with the Ministry of Health. All positive study subjects were given anti-malaria drugs (chloroquine and arthemeter lumefantrine) free of charge immediately after diagnosis.

A descriptive analysis of cases and interviewed individuals was conducted, followed by univariate and multivariate analyses of risk factors for malaria, using SPSS version 12 statistical software package. Stepwise multivariate analysis was carried out to determine the predictor variable for malaria. Chi-square test was used to check associations between different variables and their significance and strength with 95% confidence interval.

RESULTS

In the period between 2001 and 2005 malaria has been the major cause of morbidity and mortality in Finchaa, with a total of 22,040 microscopically confirmed malaria cases (4,408/year) treated at the FSF health center. Mean monthly malaria prevalence of outpatients fluctuated between 5 and 45%, with an average of 30.9% (Figure 1).

When the status of malaria infection rate was seen in the health center, it was observed that malaria showed a steady increment from 2001 through 2004 but a slight decline by the year 2005. On the other hand, when malaria infection rate was compared with other parasites detected in the health center, respiratory infections were found to be the leading followed by malaria infection for the years 2001 to 2004 as shown in Figure 2.

DISCUSSION

Finchaa Sugar Factory (FSF), located between 1,350 m and 1,600 m a.s.l. in warm and moist lowland, falls within an area of malaria endemicity in Ethiopia. In addition to the conducive climatic factors, there exists extensive irrigation farming which could create favorable conditions

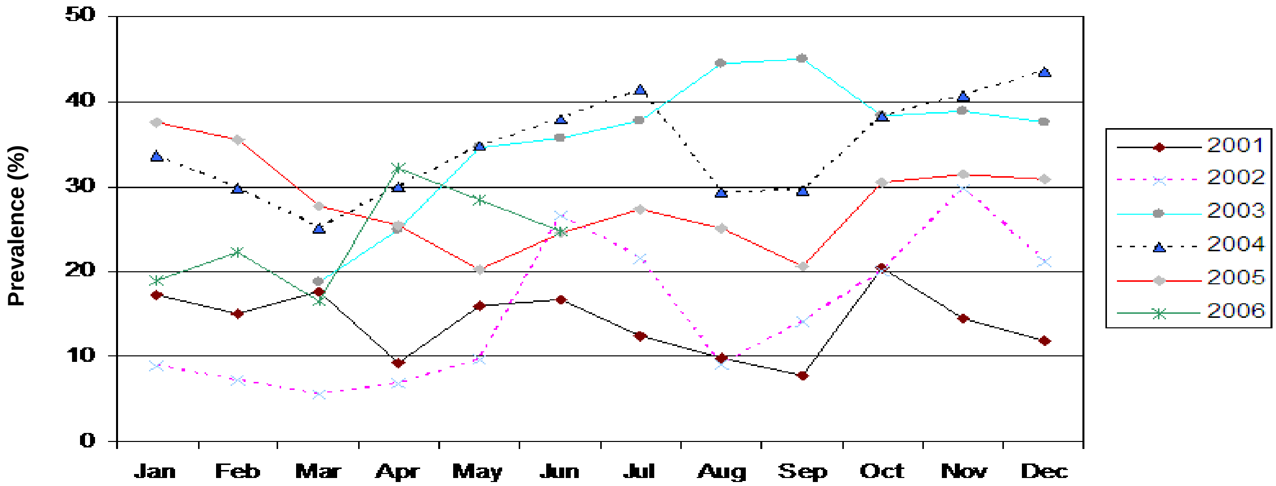

Figure 1. Clinical record of malaria prevalence in outpatients at FSF Health Center from 2001 to 2005/6.

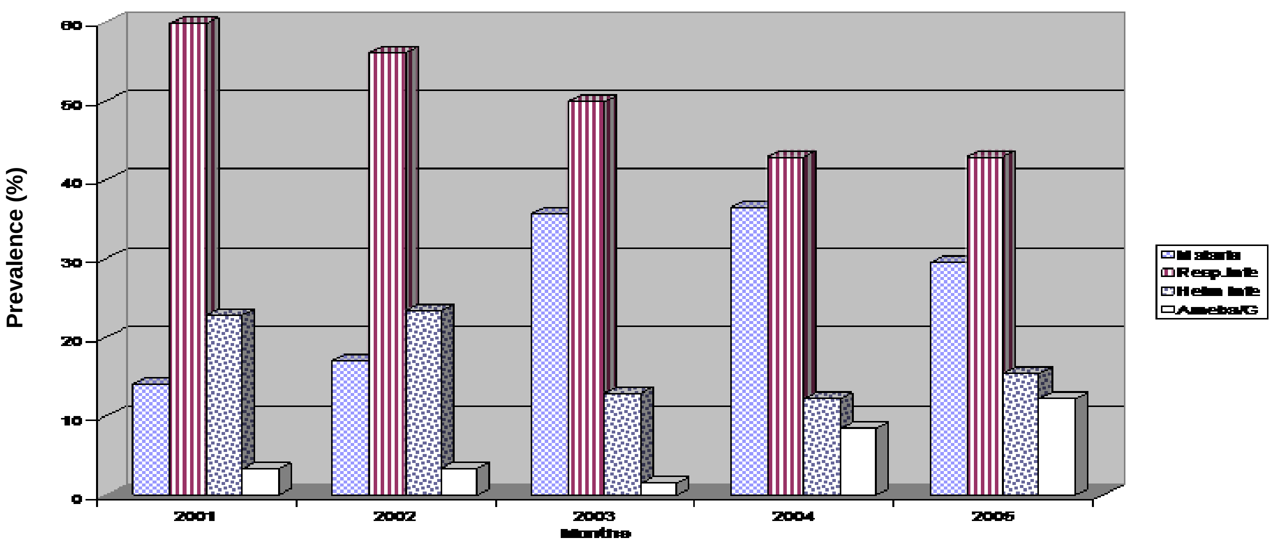

Figure 2. Clinical record of malaria prevalence in relation to other infections in outpatients in FSF Health Center from 2001 to 2005.

for a year-round malaria transmission. The moderately high mean annual minimum temperature (14.5°C) and mean annual maximum temperature (30.6°C) together with the relatively moderate moisture (62%), in FSF, would favor the breeding of mosquito vectors and enhance parasite life cycle completion inside the mosquito, a process highly dependent on environmental temperature and humidity (Zucker, 1996; Malakooti et al., 1998; Temu et al., 1998; Sutherst, 2004). The presence of temporary and permanent streams in addition to the numerous sprinklers and irrigation canals are additional factors that may favor malaria transmission throughout the year in FSF.

With the high variability within and between years, no clear transmission season can be distinguished other than a general increase in cases from April to September, but this cannot be observed for all years. Residential insecticide spraying was routinely carried out in August but only coincides with a clear reduction in prevalence in 2001, 2002 and 2004. The distribution of *Plasmodium* species showed variations from year to year as well. There was a dominance of *P. falciparum* over *P. vivax* in the year 2004, but in 2005 there was more *P. vivax*. In most years, with the exception of 2003, slightly more *P. vivax* than *P. falciparum* was observed in the dry season, whereas the reverse was true at the end of the rainy sea

Table 2. Malaria positive cases (%) in seven villages, Finchaa Sugar Factory in November 2005 and April/May 2006.

Village	November 2005				April/May2006			
	N	*P. falciparum* {No. (%)}	*P. vivax* {No. (%)}	Total {No. (%)}	N	*P. falciparum* {No. (%)}	*P. vivax* {No. (%)}	Total {No. (%)}
A	39	1 (2.6%)	2 (5.1%)	3 (7.7%)	39	0	0	0
B	34	1 (2.9%)	0	1 (.2.9%)	34	0	0	0
C	35	0	0	0	35	0	1 (2.9%)	1 (2.9%)
D	32	0	0	0	32	0	2 (6.3%)	2 (6.3%)
E	36	1 (2.8%)	1 (2.8%)	2 (5.6%)	36	1 (2.8%)	2 (5.6%)	3 (8.3%)
Agamsa	251	0	0	0	251	2 (0.8%)	2 (0.8%)	4 (1.6%)
Kuyisa	273	1 (0.4%)	3 (1.1%)	4 (1.5%)	273	10 (3.7%)	7 (2.6%)	17 (6.2%)
Overall	700	4 (0.6%)	6 (0.9%)	10 (1.4%)	700	13 (1.9%)	14 (2.0%)	27 (3.9%)

Table 3. Age-specific malaria infection and *Plasmodium* species prevalence in Finchaa in November 2005 and April/May 2006 according to the survey and clinical records from FSF Health Centre (November 2006 and May 2006).

Age	Survey participants				Clinical records			
	N	*P. falciparum* {No. (%)}	*P. vivax* {No. (%)}	Total {No. (%)}	N	*P. falciparum* {No. (%)}	*P. vivax* {No. (%)}	Total {No. (%)}
November 2005								
Under 5	140	0	1 (0.1)	1 (0.7)	648	43 (6.63)	34 (5.25)	77(11.88)
5-14 years	273	2 (0.7)	1 (0.4)	3 (1.1)	1502	447 (29.76)	153 (10.19)	600(39.95)
15 years and older	287	2 (0.7)	4 (1.4)	6 (2.1)	1502	447 (29.76)	153 (10.19)	600(39.95)
Total	700	4 (0.6)	6 (0.9)	10 (1.4)	2,150	490 (22.8)	187 (8.7)	677 (31.5)
April/May 2006								
Under 5	110	0	3 (2.7)	3 (2.7)	844	76 (9.0)	133 (15.8)	209 (24.8)
5-14 years	185	4 (2.2)	4 (2.2)	8 (4.3)	991	183(18.47)	226 (22.8)	409 (41.3)
15 years and above	405	9 (2.2)	7 (1.73)	16 (4.0)	991	183(18.47)	226 (22.8)	409 (41.3)
Total	700	13 (1.9)	14 (2.0)	27 (3.9)	1835	250 (13.6)	305 (16.6)	555 (30.2)

son.

In the parasitological survey the prevalence was much lower at an average parasite rate of 2.6%. Only 10 individuals (1.4%) were found to be malaria positive in the first survey and 27 (3.9%) in the second survey (Table 2). More than two thirds (70.3%) of the detected malaria cases were asymptomatic, with less than a third (29.7%) being febrile. Among the infected, 8.1% were pregnant women, which is in line with the 10% found in a stable transmission area in Ethiopia (Newman et al., 2003). Of the total malaria infected subjects 24.3% carried *P. falciparum* gametocytes, 54% had early stages (ring and early trophozoite) of *P. falciparum* and *P. vivax* and 21.7% were found to show mature schizont stages of *P. vivax.* Both malaria species occurred more or less at the same rate, though *P. vivax* was the only species detected among children less than five years of age. Out of the total 37 malaria positive individuals, 16 (43%) were males and 21 (57%) females (P=0.655). Parasite density ranged from very low to relatively high. Among the malaria cases, 10.8% had high parasite density (around 10% average parasitaemia) and the remaining 89.2% of cases exhibited very low to moderate parasitaemia (less than 3% average).

In both surveys, malaria infection was observed in all age groups (P=0.377). In the second survey, the highest parasite rate (4.3%) was detected in the 5 to 14 age groups, which is in line with the case rates from the FSF health center (Table 3). These cases were all *P. vivax* from the village of Kuyisa and more than half of these were from the edge of the village near the stream. The lower malaria prevalence in young children under 5 years old could point at unstable transmission (WHO, 2000; Giha et al., 2000; Muller et al., 2001; Oesterholt et al., 2006) or at occupational risk. It might be that, as in other parts of Ethiopia, *Anopheles arabiensis* acts as the main vector in Finchaa. This mosquito has been reported to shift its biting peak to earlier in the evening in northern and central Ethiopia (Yohannes 2005). Hence, adults would be exposed to more infective bites as they would still be up during et al., the most active hours of *A. arabiensis*. The epidemiological profile of FSF could also be influenced by the influx of seasonal laborers from malarious parts of the country during the main transmission period (Thomas et al., 2004). In Kenya seasonal migration of workers was associated with malaria epidemics (Bloland and Williams, 2003).

Statistically significant variation in malaria prevalence among the study sites was observed during the first parasitological survey (P<0.001), but not in the second survey (P=0.171). Village E had the highest malaria prevalence of 6.9% and the lowest malaria infection rate was detected in Agamsa with 4 cases (0.8%). Village E is located at the periphery of the area with abundant temporary pools of water from damaged irrigation pipes that created favorable mosquito breeding sites. This influence on malaria transmission by focal micro-ecological conditions in village E and Kuyisa is in agreement with the variation in malaria prevalence between central and peripheral locations in the city of Nazareth, eastern Ethiopia (Yohannes and Petros, 1996). In addition, both villages had many poor quality houses that provide little protection against malaria vectors and are less amenable to residual insecticide vector control. Moreover, the inhabitants of village E and Kuyisa are predominately daily laborers are the least paid and, unlike permanent employees of the sugar estate, have less access to free medication. At the other end of the spectrum, very low malaria prevalence (0.8%) was found in Agamsa, where the residential quarters of permanent employees were. This could be attributed to the use of personal protection methods in addition to the existing vector control measures and free treatment services. Furthermore, households from Agamsa had relatively good awareness of malaria transmission and access to its control techniques; all users of bed nets were from this village.

The number of rooms was a risk factor for malaria (P<0.001): among households with one room 62.2% had malaria cases, in two-room houses this was 32.4% and households with three rooms experienced low (5.4%) malaria infection rates. Other factors such as income source and occupation were also associated with malaria infection (P<0.05). More unemployed individuals, usually working as daily laborers, were found infected (23.8%) and increase in income was negatively associated with malaria infection rate.

Results from KAPs survey showed that malaria infection prevalence was associated with the monthly income of the subjects. As monthly income of the residents increase, decreased malaria infection prevalence was observed Table 4. There was a significant number (43.6%) of unemployed daily laborers like students who earn money on temporary conditions. Of the total 140 household heads interviewed from the seven survey sites, 91% replied that they had experienced malaria and had used anti-malaria drugs, (Table 5). When asked what brand of anti-malaria drugs they used, 55% replied Chloroquine (CQ) and Sulphadoxine-Pyrimethamine (Fansidar) whereas 26% indicated that they did not know. Furthermore, few respondents reported to have used the combination of two or more of the anti-malaria drugs.

Conclusions

The actually measured prevalence was much lower (2.6%) than that found in clinical records (30.9%). This was expected because the people seeking medical care suffer from fever or other symptoms. Moreover, people may suffer several episodes per year that would all be counted as separate cases in the FSF health center. Still, the difference was very high and may justify extra quality control at the health center. Malaria is a major public health problem in the Finchaa Sugar Factory estate that puts a lot of pressure on health resources and has systematically reduced the work output of permanent and seasonal employees and led to absence from school among students. Major risk factors are environmental and socio-economic in nature, with location of villages relative to breeding sites, income, access to health services and control measures as important determinants. Malaria in large irrigated estates in Ethiopia deserves public health attention to help address the problems of continuous transmission, especially among those not served directly by the FSF health services.

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Table 4. Malaria prevalence versus monthly income of heads of household among study participants in FSF, Nov. 2005.

Number of Household heads	Monthly income categories (in Birr)						
	Unemployed	Below 200	201-400	401-600	601-1000	1001 +	Total No. (%)
Interviewed No. (%)	21(15.0)	32(22.9)	42(30.0)	25(17.8)	13(9.3	7(5.0)	140(100.0)
Infected with Malaria No. (%)	5(50.0)	2(20.0)	2(20.0)	1(10.0)	0(0.0)	0(0.0)	10(100.0)

Table 5. The proportion of household heads reported malaria infection and use of anti-malaria drugs from the seven study sites in FSF, Nov. 2005.

Survey site	No. of household heads			
	Number Interviewed	Reported malaria infection	Anti-malaria drug use	
			paid	Free
A	8	8	2	6
B	7	7	2	5
C	8	8	1	7
D	7	5	-	5
E	8	8	2	6
Agamsa	46	37	6(16.2%)	31(83.8%)
Kuyisa	56	54	38(70.4%)	16(29.6%)
Total	140(100.0%)	127(91%)	51(40.2%)	76(59.8%)

REFERENCES

Abeku TA, De Vlas, SJ, Borsboom GJJM, Tadege A, Gebreyesus Y, Gebreyohannes H, Alamirew D, Seifu A, Nagelkerke NJD, Habbema JDF (2004). Effects of meteorological factors on epidemic malaria in Ethiopia: A statistical modelling approach based on theoretical reasoning. Parasitologia, 128(6): 585-593.

Alemayehu T, Yeebiyo Y, Ghebreyesus TA, Witten KH, Bosman A, Teklehaimanot A (1998). Malaria, schistosomiasis, and intestinal parasites in relation to microdams in Tigray, northern Ethiopia. Parassitologia, 40: 259-267.

Birrie H, Medhin G, Erko B, Beshah G, Gemetchu T (1997). Intestinal helminth infections among the current residents of the future Finchaa Sugar Plantation area, western Ethiopia. Ethiop. J. Health Dev., 11(3): 219-228.

Bloland PB, Williams HA (2003). Malaria control during mass population movements and natural disasters. National Academics Press, Washington DC., p. 8-11.

Cheesbrough M (1987). Medical laboratory manual for tropical countries. ELBS Butterworth-Heinemann, Oxford, 2: 495-518.

Chimbari MJ, Chirebvu E, Ndlela B (2004). Malaria and schistosomiasis risks associated with surface and sprinkler irrigation systems in Zimbabwe. Acta Trop., 89(2): 205-213.

Deressa W, Ali A, Berhane Y (2006). Review of the interplay between population dynamics and malaria transmission in Ethiopia. Ethiop. J. Health Dev., 20(3):137-144.

FMOH (2004). Malaria diagnosis and treatment guidelines for health workers in Ethiopia. Federal Democratic Republic of Ethiopia Ministry of Health, Addis Ababa. 2: 62.

FMOH (2005). Health and health related indicators. Federal Democratic Republic of Ethiopia Ministry of Health, Addis Ababa, p. 74.

Garcia LS (2001). Diagnostic medical parasitology. ASM Press, Washington DC., 4: 850-872.

Gebre-Mariam N, Abdulah Y, Mebrate A (1988). Malaria, in: Zein, A., Kloos, H. (Eds.) The Ecology of Health and Disease in Ethiopia. EMPDA Press, Addis Ababa, pp. 136-150.

Ghebreyesus TA, Haile M, Witten KH, Getachew A, Yohannes AM, Yohannes M, Teklehaimanot HD, Lindsay SW, Byass P (1999). Incidence of malaria among children living near dams in northern Ethiopia: Community based incidence survey. B. Med. J., 319: 663-666.

Giha HA, Rosthoj S, Dodoo D, Hviid L, Satti GM, Scheike T, Arnot DE, Theander TG (2000). The epidemiology of febrile malaria episodes in an area of unstable and seasonal transmission. Trans. R. Soc. Trop. Med. Hyg., 94: 645-651.

Haile-Meskel F, Kloos H, (1989). Vector-borne occurrence and spread as affected by labour migrations to irrigation schemes in Ethiopia, in Service, M.W. (Ed.) Demography and Vector-Borne Diseases. CRC Press Boca Raton, pp. 122-134.

Keiser J, Caldas de Castro M, Maltese MF, Bos R, Tanner M, Singer BH, Utzinger J (2005). Effect of irrigation and large dams on the burden of malaria on a global and regional scale. Am. J. Trop. Med. Hyg., 72(4): 392-406.

Malakooti MA, Biomndo K, Shanks GD (1998). Re-emergence of epidemic malaria in the highlands of western Kenya. Emerg. Infect. Dis., 4(4): 671-676.

Muller DA, Charlwood JD, Felger I, Ferreira C, Smith T (2001). Prospective risk of morbidity in relation to multiplicity of infection with *Plasmodium falciparum*, Sao Tome. Acta Trop., 78: 155–162.

Newman RD, Hailemariam A, Jimma D, Degifie A, Kebede D, Rietveld AEC, Nahlen BL, Barnwell JW, Steketee RW, Parise ME (2003). Burden of malaria during pregnancy in areas of stable and unstable transmission in Ethiopia during a nonepidemic year. J. Infect. Dis., 187(11): 1765-1772.

Oesterholt MJ, Bousema JT, Mwerinde OK, Harris C, Lushino P, Masokoto A, Mwerinde H, Mosha FW, Drakeley CJ (2006). Spatial and temporal variation in malaria transmission in a low endemicity area in northern Tanzania. Malar. J., 5(98) : 1-7.

Temu EA, Minjas JN, Coetzee M (1998). The role of four anopheline species in malaria transmission in coastal Tanzania. Trans. R. Soc. Trop. Med. Hyg., 92:152-158

Thomas CJ, Davies G, Dunn CE (2004). Mixed picture for changes in stable malaria distribution with future climate in Africa. Trend. Parasitol., 20: 216-220.

WHO (2000). The epidemiological approach to malaria control. WHO unpublished document. Part II. WHO/CDS/CPE/SMT/ 2000.1. World Health Organization, Geneva, p. 62.

Yohannes M, Haile M, Ghebreyesus TA, Witten KH, Getachew A, Byass P, Lindsay SW (2005). Can source reduction of mosquito larval habitat reduce malaria transmission in Tigray, Ethiopia? Trop. Med. Int. Health, 10(12): 1274–1285.

Yohannes M, Petros B, 1996. Urban malaria in Nazareth, Ethiopia: Parasitological studies. Ethiop. Med. J., 34: 83-91.

Zucker JR (1996). Changing patterns of autochthonous malaria transmission in the United States: A review of recent outbreaks. Emerg. Infect. Dis., 2(1): 37-43.