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Seasonal Patterns of Malaria Morbidity in Two High Altitude Sites in Kakamega District, Western Kenya

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ABSTRACT

A malariometric study was carried out in two high altitude sites, Mumias and Malava, in Kakamega district. Mumias supports large sugarcane plantations while Malava is forested with mainly subsistence farming being practised. The prevalence of malaria infection among children was high and showed seasonal variation in both study sites. In Mumias, parasite rates peaked up at 58.3% in the wet season while in Malava a 48.3% parasite rate was recorded in the same season. The values for the corresponding dry season in Mumias and Malava were 43.0% and 32.0% respectively. Parasite rates were highest in the 5-9 years age group (range 40.6%-69.4%). However, the highest parasite densities were recorded in the younger children 3-12 months old. Significant variation in parasite densities between age groups was evident. The predominant species, *Plasmodium falciparum*, was present in 85.4% of all positive slides, *P. malariae* in 5.5% and 9.1% of the slides had both *Plasmodium* species. *Plasmodium ovale* and *P. vivax* were not present among the positive cases recorded. Gametocytes were present in 15.6% of the slides examined. No significant seasonal variation in gametocyte rates was observed in both study sites. The present study shows that the level of malaria infection is high and occurs year round in the high altitude sites in western Kenya. Control measures and improvements in the availability of basic health facilities and services should therefore be offered much needed attention in order to alleviate the problem of malaria in this region.

INTRODUCTION

Despite the implementation of control strategies in most endemic regions and concerted research efforts into new innovations, malaria still remains the single most important disease in the tropics and sub tropics. In 1995, the number number of cases of malaria world wide was estimated at 300-500 million (WHO 1996). In Africa, malaria is estimated to cause more than 100 million clinical episodes and prevalence of infection is estimated to be over 275 million parasite carriers (WHO 1993). In Kenya, the magnitude of the health problem posed by malaria is high especially in western and on the coast of Kenya. It is a major cause of illness and death in children in these areas. In some areas estimates of infant and child mortality indicate that at least 58 infants per 1,000 life births and 12 children per 1,000 children aged between 1-4 years die each year of the disease (Snow et al. 1994). Malaria in humans is caused mainly by four protozoan species of the genus *Plasmodium: P. falciparum, P. malariae, P. vivax and p. ovale* (Giles 1995).Falciparum malaria is the most important of the four species of *Plasmodium*, and in the tropical regions it is responsible for at least 85-90% of all malaria cases. It is an important cause of abortion, stillbirth and death in non-immune individuals in these areas. The malaria situation is worsening since access to formal health services in much of the affected areas is becoming even more limited. Serious constraints such as vector resistance to insecticides, parasite resistance to drugs, political instabilities and poverty in much of the African continent offer even serious challenges to the management of malaria. The present study was undertaken to assess seasonal patterns of malaria prevalence in high altitude sites in western Kenya where life threatening levels of malaria exist but so far given very little attention.

MATERIALS AND METHODS

Study sites

Malariometric surveys were conducted in Mumias and Malava divisions of Kakamega district, western Kenya. Mumias is a sugarcane growing zone and has an altitude of about 1,500 metres a.s.l. It has a total population of 206,456 inhabitants with a population density of 355 persons per km^2. It has a total of 45,981 households and covers an area of about 581 km^2. Malava on the other hand is a forested zone and lies between 1.65 km and 1.8 km a.s.1.Malava division has 148,812 inhabitants in an area of 527 km^2 with a population density of 282 persons per km^2 (Republic of Kenya, 1989). The popularion which live in scattered villages practise mainly subsistence farming. Both study sites are well served with medical centres and dispensaries. The government sponsored

Makunga Health Centre and St. Mary's Mission Hospital provide health services to a large part of the population in the division in Mumias while the Malava sub-district hospital provide out-patient and limited in-patient services in the division with a few local dispensaries also offering similar services. Similarly private physicians provide medical services, and proprietary forms of antimalarial drugs may be purchased from shops. Trained village health workers provide essential basic medical advice to the population as well as treating common ailments and uncomplicated malaria.

Malaria morbidity surveillance

Parasitological surveys were carried out in Mumias and Malava in July-September and December-February (corresponding to the wet and dry seasons respectively). Apparently healthy children (n=472) aged between 3 months to 15 years with no signs of fever or history of fever at least two weeks before the study commenced were recruited into the study following consent by parents and / or guardians. Thin and thick blood smears were prepared from finger prick blood samples. After Giemsa staining, parasitaemia was estimated by counting the number of malaria parasites against 200 white blood cells. Two independent readings were done for every slide to determine the level of parasitaemia and gametocyte rates.

RESULTS

Plasmodium falciparum and P. malariae infection

The parasitological surveys conducted in Mumias and Malava indicated high prevalences of malaria infections among apparently healthy, asymptomatic children screened in July-September and December-February. This corresponded to the wet and dry season experienced in this region. The rainfall totals of 470.7 mm and 326.6 mm were recorded in Mumias in the wet season (July-September) and dry season (December-February) respectively. Corresponding rainfall totals were 672.6 mm and 240.2 mm in the wet and dry season in Malava. *Plasmodium falciparum* and *P. malariae* were the only *Plasmodium* species identified among the slides examined. The distribution of the two *Plasmodium* species is shown in Table 1 by site and season.

Pure *P. falciparum* (85.4%, n=187) formed a large proportion of the total positive slides examined while *P. malariae* accounted for 5.48% (n=12). Mixed infections of *P. falciparum* and *P. malariae* were observed in 9.13% (n=20) of the total *Plasmodium* positives slides. Overall, *P. falciparum* accounted for 94.5% (n =207) of the infected cases while *P. malariae* was responsible for 14.6% (n=32). The total percentage is greater than 100 since slides with mixed infection were

considered twice in this calculation. Therefore, as would be expected, *P. falciparum* has greater contribution to illness due to malaria in this region.

Table 1. Relative proportions of *P. falciparum* and *P.malariae* in asexual bloodstage positive cases.

Site	Month +ve	No.Pf +ve	%Pf +ve	No.Pm +ve	%Pm Pm+ve	No.Pf& Pm+ve	%Pf& +ve	Total
Mumias	Jul-Sep	57	85.1	1	1.49	9	13.4	67
	Dec-Feb	39	84.8	2	4.35	5	0.0	46
Malava	Jul-Sep	60	81.2	9	12.20	5	6.8	74
	Dec-Feb	31	96.9	0	0.00	1	3.1	32
Total		187	85.4	12	5.50	20	9.1	219

Pf: *P. falciparum*, Pm: *P. malariae*

Infection rates

A year round transmission of malaria was observed in both study sites with seasonal variation in malaria parasite rates. Table 2 shows the age pattern of malaria infection and parasite densities in samples of population in Mumias and Malava.

Table 2 Age distribution of malaria infection and parasite densities in children in Mumias and Malava.

		July - September			December - February		
Site	Age (years)	No. examined	%parasit -aemic	Geometric mean density	No. examined	%parasit -aemic	Geometric mean density
Mumias	<1	14	42.9	2,345.6	11	45.5	2,465.9
	1-4	36	61.1	1,748.6	29	48.3	848.1
	5-9	36	69.4	1,092.6	40	45.0	763.7
	10-15	29	48.3	926.7	27	37.0	761.0
Malava	<1	36	33.3	2,491.9	16	25.0	3,191.7
	1-4	44	54.5	1,008.4	39	30.8	1,104.2
	5-9	41	61.0	770.4	32	40.6	733.9
	10-15	29	41.4	591.9	13	23.1	653.4

A relatively higher proportion of children screened in the wet season had malaria parasites in their blood streams (Mumias=58.3%, Malava=48.7%) than in the dry season (Mumias=43.0%,Malava=32.0%) in both study sites. These differences in parasite rates during the two seasons in both study sites were significant ($F_{3,12}=4.718$, $p=0.021$) suggesting that malaria transmission in the study sites changed with season. Variation was also observed in parasite rates and mean parasite densities (number of parasites/μl blood) in different age groups. High parasite rates (69.4% in Mumias and 61% in Malava) were recorded among children in the 5-9 years age group especially so in the wet season (Fig. 1). The difference in parasite rates between age groups within the two study sites was significant ($F_{3,12}=9.08$, $p<0.001$).

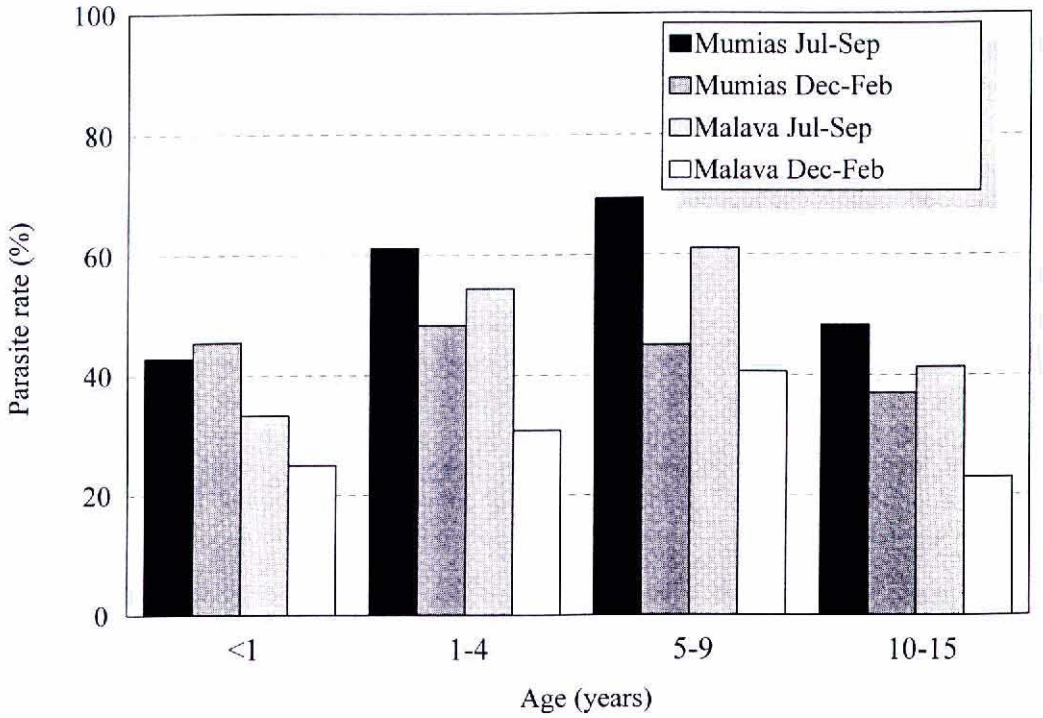

Figure 1. Distribution of malaria infection according to age among children in Mumias and Malava.

Parasite densities

At both sites the mean parasite densities (number of parasites / μl blood)

were higher in less than 12 months old children (Table 2). A significant variation in parasite densities was evident between age groups in the study sites ($F_{3,12}$= 34.57, $p<0.001$). Similar trends were observed both in the wet and dry season, with parasite densities showing strong inverse relation to age. The relationship between age and parasite density is shown in figure 2. The differences in parasite densities between sites were, however, not significant ($F_{3,12}=0.873$, $p=0.482$). *Plasmodium falciparum* gametocytes were observed in 15.6% (74/472) of the total slides examined. The number of slides positive for gametocytes from Mumias (17.1%, 38/222) and Malava (14.4%, 36/250) were not significant. The highest proportion of gametocyte carriers was among children below the age of your years and gametocyte rates tended to decrease with age. The gametocyte rates in the dry and wet season in both sites were identical.

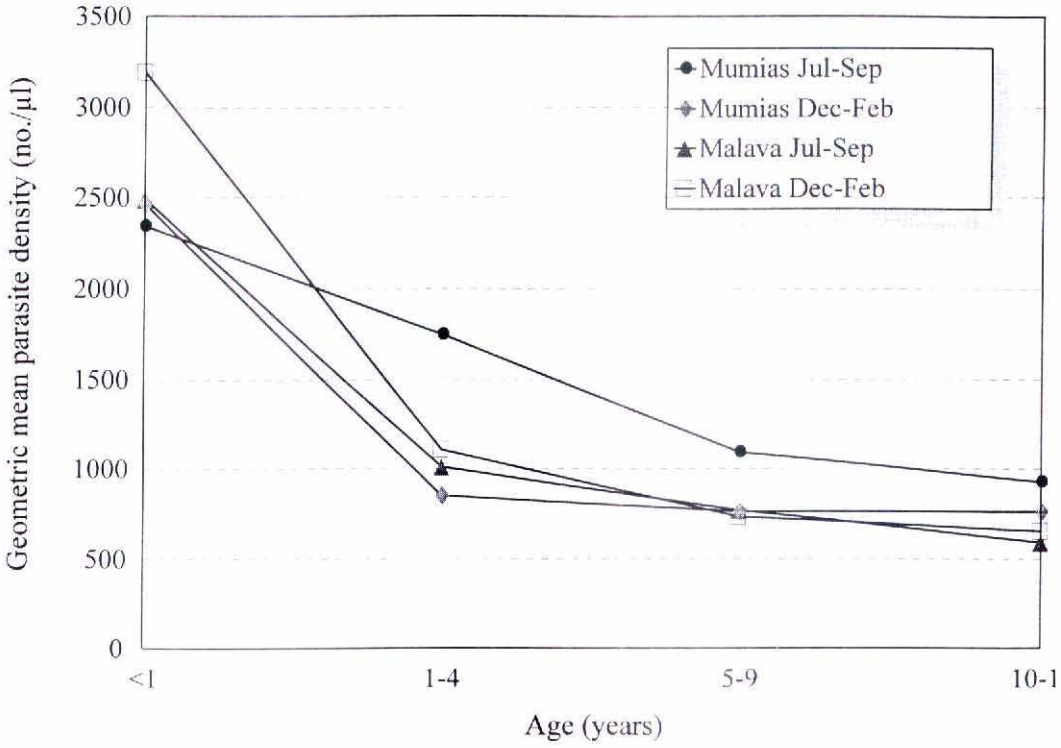

Figure 2. Relationship between age and parasite density in samples of population in Mumias and Malava.

DISCUSSION

Our results indicate the occurrence of high, year-round, prevalences of *P.*

falciparum parasitaemias among children in in the high altitude regions. The prevalence of infection showed marked seasonal variation. However, the mean parasite rates recorded in Mumias (51.1%) and Malava (40.4%) were generally lower than those obtained from areas on the shores of Lake Victoria where parasitaemia prevalence among apparently healthy children may be as high as 94.7% (Beier *et al.*, 1994). This confirms a comparatively low level of malaria transmission in Kakamega compared to areas near Lake Victoria. An important demonstration in the present study is the lack of any significant variation in parasite rates between both study sites although Mumias has been shown to have a 4 fold entomological inoculation rate (EIR) as compared to Malava. This observation may either indicate that the level of transmission intensity as estimated by entomological indices such as EIR may not reveal the real picture of malaria prevalence / incidence or that even under conditions of very low levels of malaria transmission appreciably high prevalences of malaria are expected. Attempts have been made to establish the relationship between transmission intensity and malaria prevalence. However, these studies have not established any appreciable correlation between prevalence / incidence of *P. falciparum* infection and the rate of exposure to sporozoite infected mosquitoes (McElroy *et al.*, 1994 ; Mbogo *et al.*, 1995). The findings from these studies, as well as the present investigation, show that even very low levels of malaria transmission are able to maintain important levels of malaria in the population. The need therefore for control efforts even under situations of low malaria intensity is clearly demonstrated. The highest prevalence of parasitaemia was in children aged 5-9 years old while infants below one year of age exhibited the highest parasitaemias in both study sites. An inverse relationship between age and parasite density was established in the present study. In endemic areas malaria related mortality is higher in children under the age of five years. This can be attributed to low anti-*P.* falciparum immunity because of low exposure to *P.falciparum* hence there is a high probability among younger children of developing high parasitaemias relative to their older counterparts under the same transmission conditions. The low levels of *P. malariae* positive cases observed in the present study are generally expected in most endemic areas. Throughout endemic areas of Africa, lower prevalences of *P. malariae* than *P. falciparum* are generally observed. Binka *et al.* (1994), in a malariometric survey in the Kassena-Nankana district in the upper east region of Ghana, found *P. falciparum* (70.6%) to be the predominant species followed by *P.malariae* (16.9%), *P. ovale* (7.9%) and *P. vivax* in 1.4% of the cases examined. In the Siaya district, western Kenya, P. falciparum was shown to predominate in 94.4% of cases screened with *P. malariae* and *P. ovale* having an overall prevalence of 25.6% and 16.4% respectively (McElroy *et al.*, 1994). The presence

of gametocyte carriers is one factor that significantly modulates infection in mosquitoes, and therefore affects the overall pattern of malaria transmission. Evidence from a series of studies show that gametocyte density and prevalence tend to be higher among very young children and decreases with age (Githeko *et al.*, 1992; Boudin *et al.*, 1991). The results of the present study demonstrate the important contribution of young children to the dynamics of disease transmission in an endemic area as important reservoirs of malaria. Based on the present survey serious efforts are needed for the control of malaria in Kakamega district.

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