

Short communication

Epidemiology of malaria in New Halfa, an irrigated area in eastern SudanY.El-S. Himeidan,¹ M.I. Elbashir,² El-A. El-Rayah² and I. Adam³وباء الملاريا في حلفا الجديدة، منطقة تروى اصطناعياً في شرق السودان
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الخلاصة: تم من خلال دراسة استباقية تقصي وباء الملاريا في منطقة زراعية في شرق السودان، وذلك خلال الفترة من تشرين الثاني/نوفمبر 1999 حتى حزيران/يونيو 2000 (موسم ربي وموسم جفاف). ومن واقع المسوحات الطفيلية الشهرية كانت 1539/99 من لطاخات الدم التي أخذت من 190 شخصاً إيجابية للإصابة بالملاريا: 95% ملاريا المتصورة المنجلية و3% ملاريا المتصورة النشيطة و2% ملاريا المتصورة البيضوية. وقد تراوح معدل إيجابية الشرائح لنوبات الملاريا بين 3.7% إلى 12.8%. وذلك على مدى شهور المسح المختلفة مع بلوغها حد الذروة في شهر كانون الثاني/يناير. ولم يكن هناك اختلاف يُعتدُّ به إحصائياً في معدل إيجابية الشرائح بين موسم الري وموسم الجفاف (7.2% مقابل 5.1%). وقد اختلف معدل الإيجابية الشريحية بشكل يُعتدُّ به إحصائياً حسب الفئة العمرية حيث وقع أعلى معدل ضمن فئة الأطفال من عمر 5 سنوات. ولو أنه لم يُلاحظ فرق كبير بين الذكور والإناث. وكانت سرية وشدة الإصابة بالملاريا في هذه المنطقة حَوْلِيَّة perennial ومعتدلة بدلاً من كونها منخفضة.

ABSTRACT A prospective study investigated the epidemiology of malaria in an agricultural area in eastern Sudan from November 1999 to June 2000 (1 irrigation and 1 dry season). In monthly parasite surveys, 99/1539 blood films from 190 individuals were positive for malaria: 95% for *Plasmodium falciparum*, 3% *P. vivax* and 2% *P. ovale*. The slide positive rate (SPR) of malaria episodes ranged from 3.7% to 12.8% in different months of the survey, with a peak in January. There was no significant difference in SPR between irrigation and dry seasons (7.2% versus 5.1%). SPR differed significantly by age group and was highest in under 5-year-olds. However, there was no significant difference in SPR between males and females. Transmission and intensity of malaria in this area is perennial and moderate rather than low.

Épidémiologie du paludisme à New Halfa, une zone irriguée du Soudan oriental

RÉSUMÉ Une étude prospective a examiné l'épidémiologie du paludisme dans une zone agricole du Soudan oriental de novembre 1999 à juin 2000 (1 saison d'irrigation et 1 saison sèche). Dans les enquêtes parasitaires mensuelles, 99 des 1539 étalements de sang prélevé sur 190 personnes étaient positifs pour le paludisme : 95 % pour *Plasmodium falciparum*, 3 % pour *P. vivax* et 2 % pour *P. ovale*. Le taux de lames positives pour les épisodes de paludisme se situait entre 3,7 % et 12,8 % pour les différents mois de l'étude, avec un pic en janvier. Il n'y avait pas de différence significative dans le taux de lames positives entre la saison d'irrigation et la saison sèche (7,2 % contre 5,1 %). Le taux de lames positives différait significativement selon le groupe d'âge et était le plus élevé chez les moins de 5 ans. Toutefois, il n'y avait pas de différence significative selon le sexe dans le taux de lames positives. La transmission et l'intensité du paludisme dans cette zone perdurent et sont modérées plutôt que faibles.

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Introduction

Malaria accounts for 10% of Africa's total disease burden [1]. The epidemiology of malaria is important in terms of understanding the basic immunological processes, as well as in deciding the control strategies to apply. It has been suggested that the clinical course of malaria is likely to differ according to the transmission in the area. Therefore, in areas where malaria transmission is seasonal and unstable, the disease burden is confined to a wide age range, and adults as well as children suffer severe morbidity. In areas with intense transmission, however, the burden of disease is confined to the youngest age groups, as adults would have already developed immunity and the highest incidence would be among children under 5 years old [2-4].

While the epidemiology of malaria has been studied in other areas of Sudan [5-7], no data is available from the New Halfa area of eastern Sudan, which has the second largest permanent irrigation scheme in Sudan. Permanent irrigation has been reported to influence the transmission of malaria adversely [8,9]. The present study was conducted to continue our previous entomological work in this area of eastern Sudan [10], to investigate the morbidity pattern of malaria in the area and to establish adequate baseline data for evaluation of the effectiveness of various preventive measures, including future vaccines.

Methods

Study area

The study was carried out in 2 localities (Heielmasakine and Dibaira camp), which are surrounded by free-hold farms in the north and south of New Halfa town, respectively. The study area has been de-

scribed in detail elsewhere [10]. In summary, New Halfa area lies in the semi-arid belt of Sudan approximately 500 km east of Khartoum in the middle of an agricultural scheme. Cotton, wheat, sorghum and various vegetables are cultivated in area of 400 000 feddans. The total rainfall and the average temperature during the study period were 431.6 mm and 30 °C respectively. *Plasmodium falciparum* is the predominant malaria parasite species, and has been shown to be 75.0% and 9.6% resistant to chloroquine and quinine respectively [11].

Parasitology survey

A cohort of 195 individuals from all age groups was randomly selected, which represented 14% of the population in both localities (95 from Heielmasakine and 100 from Dibaira camp). Of these, 5 cases were excluded initially from the study as they were positive for *P. falciparum*. Blood samples were taken from patients every month during the period November 1999 to June 2000 to determine the rate of new cases of malaria parasite infection. The first 4 months (1 November to 29 February) were considered an irrigation season and the remaining 4 months (1 March to 30 June) were considered the dry season.

After obtaining verbal consent from patients, a closed-ended questionnaire was completed to determine their sociodemographic characteristics. A blood sample was taken by finger prick for preparation of thick and thin smears. Blood films were Giemsa-stained and the thick films were examined for malaria parasites. If these were positive, the thin films were read to determine the parasite species. A slide was considered negative after examination of 200 fields of thick blood films. Clinical malaria was defined as a positive slide and a body temperature ≥ 37.5 °C.

Patients who had blood films positive in 2 consecutive months were classified and reported as treatment failure rather than re-infection. The slide positive rate (SPR) (%) was expressed as the number of positive slides/total number of slides examined

As a high level of chloroquine-resistant *P. falciparum* species is present in the area [11], all patients who had clinical symptoms confirmed by positive blood films were treated with pyrimethamine/sulfadoxine (Fansidar) followed by quinine if necessary.

Statistical analysis

The data were analysed using SPSS, version 10. Percentages, means and standard deviations (SD) were calculated. The difference in the rate of parasitaemia between different age groups, seasons, sites and sexes were compared using chi-squared tests. $P < 0.05$ was considered significant.

Results

Of the final cohort of 190 patients, 93 (48.9%) were males and 97 (51.1%) females. The mean (SD) age was 15.4 (13.9) years and mean (SD) weight 35.0 (20.4) kg.

During the 8 monthly surveys, 1542 blood films for malaria were prepared for the 190 patients, and 102 slides were found to be positive. Three positive slides were excluded and considered treatment failure as they were found positive from the same individuals in 2 consecutive months. Thus 99/1539 slides were positive, an overall SPR of 6.4% (95% CI: 3.9–9.0). Among the 99 positive slides, 95% were positive for *P. falciparum*, 3% for *P. vivax* and 2% for *P. ovale*.

The SPR of parasitaemia was 7.3% in Dibaira camp and 5.7% in Heielmasakine

($P > 0.05$). The SPR ranged from 3.7% to 12.8% during the different periods of the study. The peak was in January (12.8%), gradually decreasing in the following dry 4 months and starting to rise at the beginning of the rainy season in June (Figure 1). There was no statistically significant difference in the overall SPR of malaria parasitaemia between the irrigation and the dry seasons: 7.2% versus 5.1% ($P > 0.05$).

The SPR in different age groups in the 2 seasons (Table 1) was significantly higher in children < 5 years (10.4%) and 5–9 years (9.7%) than in those aged ≥ 20 years (1.9%) ($P < 0.0001$). The SPR was higher in males (50/646, 7.7%) than in females (49/893, 5.5%), but this was not statistically significant.

Discussion

This is the first epidemiological survey to investigate malarial morbidity in an agricultural area in eastern Sudan. The area has been characterized by a high level of chloroquine resistant falciparum malaria and a relatively high human biting rate of the principle vector *Anopheles arabiensis* [10,11]. *P. falciparum* was the predominant species detected during the survey. This agrees with our previous study of drug resistance in the same area [11]. In a nearby area, El Gadaref, recent reports showed very similar findings, and the presence of *P. vivax* was attributed to population influx from neighbouring Ethiopia [5,6]. However, in the last parasitology survey in the capital, Khartoum, relatively high percentages of *P. ovale* and *P. vivax* (8.2% and 6.9% respectively) were reported and this was explained by the mixture of inhabitants in Khartoum, many of whom are internally displaced people from south Sudan [7].

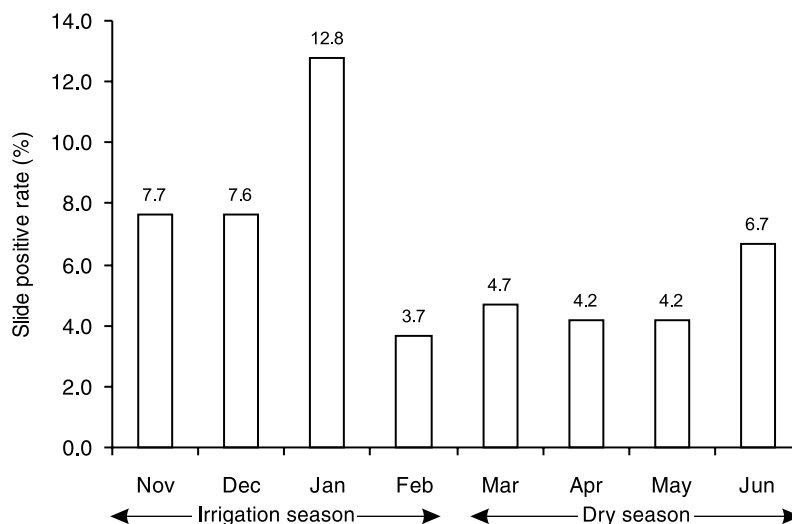


Figure 1 Seasonal variation of *Plasmodium falciparum* infection in the New Halfa area of Sudan during the study period (November 1999 to June 2000)

The study showed that the monthly SPR of malaria ranged from 3.7% to 12.8% during the study period, with the peak during January, 3 months following

the rainy season. This rate is much higher than that estimated in a nearby village (Asar) located about 150 km from New Halfa town where there is no permanent irriga-

Table 1 Slide positive rate (SPR) of *Plasmodium falciparum* infection in the New Halfa area of Sudan by age and season for 190 patients during the study period (November 1999 to June 2000)

Age (years)	Irrigation season		Dry season		Total		P-value ^b
	No. +ve/ tested	SPR (%)	No. +ve/ tested	SPR (%)	No. +ve/ tested	SPR (%)	
< 5	22/188	11.7	10/121	8.3	32/309	10.4	0.333
5-9	23/220	10.5	10/120	8.3	33/340	9.7	0.528
10-14	10/151	6.6	5/95	5.3	15/246	6.1	0.664
15-19	9/93	9.7	1/76	1.3	10/169	5.9	0.022
≥ 20	6/320	1.9	3/155	1.9	9/475	1.9	0.964
Total	70/972	7.2	29/567	5.1	99/1539	6.4	0.130
P-value ^a	< 0.001		0.032				

^aComparing across age groups.

^bComparing irrigation and dry seasons.

tion system [12]. We have previously observed this peak in an earlier survey in this area and we proposed that it might be the result of irrigation of the main crops during this period [10]. Similar findings of this peak during the irrigation of crops has been reported from the area around the Gezira irrigation scheme in central Sudan [13] as well as in other African countries. For example, in the Tigray region of Ethiopia the overall incidence of malaria was 7 times higher in villages close to micro-dams compared with control villages [9], and in the Benoue River valley of northern Cameroon, malaria incidence increased after the large-scale irrigation development following completion of the Lagdo dam [8,9]. In the present study, the peak of infection during January and the presence of malaria cases during all periods of the study—with no statistically significant difference in SPR between the dry and irrigation seasons—was different from the incidence of malaria in eastern Sudan, which varies considerably from year to year depending on rainfall [14,15]. Thus, the permanent irrigation in this area has influenced the pattern of the disease and the transmission is perennial rather than seasonal.

Although malaria episodes were observed in all age groups, the SPR varied considerably between different age groups. The most noticeable observation was the consistently reduced risk of having clinical malaria after the age of 20 years compared with infants and young children (0–9 years of age). The latter represents 66.7% of all positive cases detected in the area and the difference was highly significant ($P <$

0.0001). Recent work on the age-specific risk for malaria in eastern Sudan showed that the prevalence of malaria was high up to the age of 19 years [5,15], whereas in the capital Khartoum, the susceptibility to malaria was higher in the age group 2–9 years compared with those aged over 15 years [7]. However, in areas of intense transmission the main burden of the disease is usually confined to children under 5 years old [3]. Nevertheless, our findings do not rule out an intrinsic role for age in the development of natural immunity against *P. falciparum* malaria, but it does indicate that malaria transmission in this area is more likely to be moderate or high because the transmission intensity is roughly reflected in the point prevalence of parasitaemia in children [16].

The study showed that the SPR of malaria was not statistically different between males and females. The sex variation on malaria risk in an area of low and seasonal transmission in eastern Sudan varied from one season to another [5]. However, in a population close to Lake Zwai in central Ethiopia the malarial episodes were significantly higher in males than females. The phenomenon was explained by the observation that males are more likely to spend the evening hours outdoors, a favourable time for vector biting [17].

In conclusion, the findings of the study suggest that preventive measures against malaria such as chemoprophylaxis and bednets, should be employed in the New Halfa area for all age groups and at all times of the year.

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