

Malaria signs and infection rate among asymptomatic schoolchildren in Hajr valley, Yemen

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علامات الملاريا ومعدلات العدوى بين أطفال المدارس عديمي الأعراض في وادي الحجر، باليمن
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الخلاصة: قام الدارسون بتسجيل علامات الملاريا ومعدل وجود الطفيليات في دم أطفال المدارس العديمي الأعراض في وادي الحجر، بمحافظة حضرموت في اليمن. وتم تحري طفيليات الملاريا وفقر الدم لدى 469 تلميذاً من تلاميذ المدارس الابتدائية الذين تم انتقاؤهم عشوائياً من الذين تتراوح أعمارهم بين 6 و11 عاماً، بالإضافة إلى الاختبارات السريرية لتحديد حجم الطحال، وكذلك اللقاءات الشخصية الهادفة إلى دراسة العوامل الاجتماعية والديموغرافية، فتبين أن شرائح دم الملاريا إيجابية لنحو 12.8% من الأطفال، وأن 11.3% لديهم تضخم في الطحال. وهكذا فقد كان هناك ترابط وثيق بين العدوى بالملاريا وفقر الدم وتضخم الطحال والحمى. كما أن الأطفال الذين يعانون من وجود طفيليات الملاريا في الدم غالباً ما يتغيبون عن المدارس.

ABSTRACT This study recorded malaria signs and the rate of parasitaemia among asymptomatic schoolchildren in Hajr valley, Hadhramout governorate, Yemen. Tests were made for malaria parasites and anaemia in 469 randomly selected primary-school children aged 6–11 years, together with clinical examination to determine spleen size, and interviews to study sociodemographic factors. Of the children, 12.8% had positive malaria blood films and 11.3% had spleen enlargement. There were significant associations between malaria infection, anaemia and splenomegaly and fever. Children with malaria parasitaemia were more often absent from school.

Signes de paludisme et parasitémie palustre chez des écoliers asymptomatiques de la vallée du Hajr au Yémen

RÉSUMÉ Cette étude a consisté à enregistrer les signes de paludisme et à mesurer la parasitémie palustre chez des écoliers asymptomatiques de la vallée du Hajr, gouvernorat d'Hadhramout, au Yémen. Chez 469 élèves du primaire âgés de 6 à 11 ans, sélectionnés par randomisation, il a été procédé à des tests de dépistage des parasites du paludisme et de l'anémie, associés à la détermination clinique du volume de la rate et à un entretien visant à évaluer les facteurs sociodémographiques. Sur l'ensemble de cet échantillon d'enfants, 12,8 % présentaient un frottis sanguin positif pour le paludisme et 11,3 % une splénomégalie. Les quatre entités paludisme, anémie, splénomégalie et fièvre se sont avérées associées de manière significative. L'absentéisme scolaire était plus fréquent chez les enfants porteurs d'une parasitémie palustre.

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Introduction

Malaria is a complex condition that is manifested differently in different parts of the world depending on a number of variables. These include the infecting parasite and its susceptibility to antimalarial drugs, the distribution and efficiency of the insect vectors, climatic and environmental conditions, the person's genetic composition and acquired immunity, and the behaviour of the human population [1,2]. Some villages, families or individuals are more at risk than others [3,4]. Housing conditions play an important role in acquiring the infection [5]. The endemicity of malaria in a community is measured by the rates of spleen enlargement and parasite counts [6,7]. Malaria in pupils is a major cause of absenteeism and probably reduces the effectiveness of their education [8,9].

Various studies have been undertaken to investigate the problem of malaria in Yemen. The most predominant species of malaria parasite in the country is *Plasmodium falciparum* [10]. School surveys in Hodeidah on the west coast [11] and Socotra Island [12] aimed to evaluate the malaria situation in these districts and to prepare a plan for malaria control in one of the governorates as a pilot project. Malaria has been reported to be the main cause of outpatient morbidity in Hajr valley of Hadhramout governorate [13], but no comprehensive previous study has been conducted in the area.

The aim of this study was to record the prevalence of the signs of malaria and the parasite rate among asymptomatic school-children in Hajr valley, Yemen.

Methods

A cross-sectional design was employed on asymptomatic primary-school children

aged 6 to 11 years in Hajr valley during March 2001.

The total population of Hajr valley was about 38 000 in the year 2000. Ten out of 22 primary schools were selected by simple random sampling. The total number of pupils in primary school classes 1–3 was 2842 and a sample of 500 pupils was selected from them using the *Epi-Info* version 6 random number list. Children over 11 years old were excluded.

To test for malaria parasites, blood samples were taken and thick and thin blood films were prepared for each child, fixed with absolute methanol, stained with Giemsa stain (3% of stock) and examined under oil immersion lenses. To test for anaemia, a drop of finger-prick blood was examined by the cyanmethaemoglobin method to estimate haemoglobin levels. The cut-off for anaemia was defined as a haemoglobin level < 11.5 g/dL. To determine enlarged spleen, a clinical examination was made and spleen size was classified according to Hackett's classification (0–5). Classes ≥ 2 were considered enlarged for the purpose of analysis.

Interviews were made with the parents of the children to collect data related to age, history of fever, proximity of residence to breeding sites and school data. School performance was classified for the purpose of this study as "repeat year" and "new entrants". Repeat year pupils were those who did not succeed in the previous year while new entrants were children who succeeded. Newly enrolled pupils in class 1 were not included. Absenteeism from school was recorded by classifying non-attendance (ever absent) of a child for 1 day or more during the last month as a history of absenteeism.

Data were analysed using *Epi-info*, version 6.

Results

A total of 469 schoolchildren aged 6 to 11 years completed a full investigation and interviews; 31 children were not included (5 did not fulfil the age criteria and the other 16 refused to cooperate). The mean age of the studied schoolchildren was 8.5 years and 57% were male.

More than half the children (54.6%) had at least 1 clinical sign that is an important indicator of malaria infection: splenomegaly with anaemia or hepatosplenomegaly (Table 1). Overall 228 (48.6%) out of 469 children were anaemic and 174 (37.0%) of the children had anaemia only (Table 1). A total of 53 children (11.3%) had an enlarged spleen. A higher rate of anaemia (37/53, 69.8%) was observed in the children who had enlarged spleen. Overall, 23 out of total 469 children (4.9%) had all 3 of the major signs of malaria: parasitaemia, anaemia and splenomegaly.

Malaria parasites were identified in the blood films of 60 pupils (12.8%), 36 of whom were males. The majority were aged

8–9 years (Table 2). Table 2 shows that the parasite rate increased insignificantly with age and there was no significant difference in the malaria rate by sex. Most cases (58 cases, 96.7%) were infected with *P. falciparum* and only 2 (3.3%) were infected with *P. vivax*. The prevalence of malaria parasites was higher (40/142, 28.2%) in those children whose parents reported a history of fever 1 month before the survey than in children without a history of fever (20/327) ($\chi^2 = 43.2$, $P < 0.001$). More of the children infected with malaria had anaemia (40 out of 60, 66.7%) than in the non-malaria group (188 out of 409, 46.0%) ($\chi^2 = 9.1$, $P = 0.002$).

The malaria parasite rate was significantly higher in children classified as “repeat year” (17/65, 26.2%) than “new entrants” (43/404, 10.6%) in their school performance ($\chi^2 = 12$, $P = 0.0005$). The parasite rate among the 34/131 children with a history of absenteeism was (26%, whereas among the 26/338 with no history of absenteeism it was (8%) ($\chi^2 = 28$, $P < 0.0001$).

Table 1 Distribution of asymptomatic schoolchildren by malaria parasitaemia, splenomegaly and anaemia in Hajr valley, Yemen, 2001

Signs	No. of children	% (n = 469)
Malaria parasitaemia only	12	2.6
Malaria parasitaemia and anaemia	17	3.6
Malaria parasitaemia and splenomegaly	8	1.7
Malaria parasitaemia and splenomegaly and anaemia	23	4.9
Splenomegaly only	7	1.5
Splenomegaly and anaemia	14	3.0
Hepato-splenomegaly	1	0.2
Anaemia only	174	37.1
Other	213	45.4

n = total number of children studied.

Table 2 Malaria parasite and splenomegaly among asymptomatic schoolchildren in Hajr valley, Yemen, 2001

Characteristic	No. tested	Malaria parasitaemia present		χ^2	P-value	Splenomegaly present		χ^2	P-value
		No.	%			No.	%		
Age group (years)									
6-7	121	10	8.3	3.17	0.2	10	8.3	2.27	0.32
8-9	238	33	13.9			27	11.3		
10-11	110	17	15.5			16	14.5		
Sex									
Male	275	36	13.1	0.05	0.8	36	14.2	2.13	0.14
Female	194	24	12.4			17	8.8		

A high percentage of infected children (26/134, 19.4%) were residents of the valley < 200 m below sea level and (25/235, 10.6%) resided at altitude 200–500 m above the sea level. The remainder of the children (9/100, 9.0%) lived > 500 m above sea level ($\chi^2=7.5$, $P<0.023$). The children who lived near to breeding sites (0–5 km) had a parasite rate of 49/294 (16.7%), whereas those who lived far from breeding sites (more than 5 km) had a parasite rate of 11/175 (6.3%) ($\chi^2=10.6$, $P<0.001$).

Discussion

Only 60 out of the total 469 asymptomatic schoolchildren studied had malaria parasitaemia, resulting in a malaria parasite rate of around 13% in the study area, which classifies the Hajr valley as a high-risk area. Chronic malaria leads to growth retardation, anaemia and hepatosplenomegaly [14]. In our study, falciparum malaria was found in 97% of positive cases, which indicates the East African pattern of malaria. It has been reported before that *P. falciparum* was the most common cause of malaria in Yemen [15].

In this study, around 5% of the studied children had 3 of the major signs of malaria. These were parasitaemia, anaemia and splenomegaly. A proportion of 37% of studied children were anaemic only. This high proportion may be caused by malnutrition and/or repeated attacks with malaria and possibly with other chronic diseases. The cross-sectional design of the study cannot clarify the possible association since it studied both the exposure and the outcome simultaneously. Repeated malaria infection leads to anaemia, considerable enlargement of the spleen and chronic ill health with episodes of fever [16]. The total splenomegaly rate in our study group was around 11%, with no significant association with age and sex. This agrees with findings in Sudan from Friis and colleagues [17].

The malaria parasite rate and enlarged spleen rate were significantly higher in children whose residence was at an altitude of less than 200 m than those from higher altitude, which is consistent with a previous report from Yemen [Gregory CG et al., unpublished paper for Naval Medical Research Unit, 1994]. Hajr valley lies between 200–500 m above sea level.

Therefore, *Anopheles* spp. mosquitoes are present throughout the area.

This study revealed that the school performance was lower in the pupils affected by malaria. History of absenteeism of the pupils within 1 month before the survey was significantly associated with malaria infection, and this agrees with World Health Organization reports [8,9].

A total of 227 out of 469 schoolchildren were anaemic, giving a prevalence of anaemia in the studied group of around 48%. The prevalence of anaemia in the children with malaria parasitaemia was much higher, at around 67%. Anaemia is an inevitable consequence of malaria infection, especially in children [18]. Chronic low levels of para-

sitaemia can lead to long-lasting anaemia as a result of haemolysis of parasite-infected cells [19].

Anaemia and splenomegaly were significantly associated in this study; 70% of pupils with splenomegaly were anaemic. This agrees with a study conducted in Nigeria [20]. The proportion of anaemia with splenomegaly in this survey may be used as an indicator of inadequately controlled malaria in the study area.

In conclusion, Hajr valley is a high-risk area for malaria. Anaemia and splenomegaly were associated with malaria parasitaemia. A history of fever and splenomegaly can be used as an indication of malaria in the study area.

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Correction

Prevalence of anaemia in 2–12-year-old Iranian children. *Eastern Mediterranean health journal*, 2006, Vol. 12, No. 6, pages 804–8

The final line of the French abstract should read: “La prévalence de l’anémie était significativement plus élevée en milieu rural qu’en milieu urbain”.