Microscopy is More Reliable than Questionnaire-based Methods in the Diagnosis of Malaria in School Children

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SUMMARY

The objectives of the study were to determine by the use of a structured questionnaire the prevalence of malaria and its associated symptoms amongst school children and to relate these to the prevalence of malaria determined by microscopic examination. The questionnaire was administered to 840 pupils of classes 3, 5 and 7 (age range 5 – 16 years) in 17 primary schools of the Kumba Health District of Cameroon. Blood samples were collected from the same individuals for identification of malaria parasites. The prevalence rate by microscopic examination was 41.4%, significantly higher (P<0.001) than 23.9% obtained by questionnaire survey. Headache and fever had similar prevalence rates (53.6% and 53.0% respectively) which were significantly higher (P<0.001) than the prevalence rate of malaria by microscopic examination. Other malaria – related symptoms gave rates which greatly underestimated the prevalence of malaria (P<0.001). There was no significant correlation between the prevalence rates obtained by questionnaire and the rate of malaria by microscopy. The sensitivity and specificity of these screening tests for malaria were all low. The use of the microscope as a malaria diagnostic tool at primary health care unit is strongly recommended.

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Introduction

Of all the diseases of mankind, malaria is one of the most widespread, best known and most devastating [1]. It is most common in tropical and subtropical regions where it continues to pose a major threat to the local population [2,3]. It is a leading cause of morbidity and mortality in young children and pregnant women in sub-Saharan Africa [4]. In the Kumba Health District of Cameroon, malaria is highly endemic, a situation conditioned by the high temperatures and humidity, and the heavy rainfall in the region.

In view of the rapidity with which malaria can kill if poorly managed, resources available need to be directed towards individuals and/or communities at highest risk. Epidemiological studies can identify the foci of transmission. The use of simple school questionnaires has proved successful in identifying individuals and communities at high risk of intestinal and urinary schistosomiasis [5, 6, 7, 8]. The present study builds on similar concepts and attempts to evaluate the diagnostic performance of school-based questionnaires relating to malaria-related symptoms to the laboratory diagnosis of malaria by microscopy.

Thus, the objectives of the present study were to:-

(a) Determine by questionnaire survey the prevalence of malaria and malaria-related symptoms among school children;
(b) Relate for the same individuals the prevalence of malaria and its associated symptoms obtained by questionnaire to the prevalence of the disease determined by microscopic examination, and
(c) Assess the significance of using the questionnaire as substitute for microscopic diagnosis of malaria.

Materials and Methods

Study Site

The study was carried out in the Kumba Health District of Cameroon, located in the equatorial forest belt. The area has a marked dry season extending from November to mid-March and a rainy season covering the remaining months of the year. Rainfall averages 233 cm per year while average daily temperatures range from 22 – 26^{0}C. The landscape is undulating with a number of low isolated peaks. It is characterized by dense forest with scanty undergrowth. In many locations the original forest has been destroyed by burning or cleared for logging, cultivation or human settlement, and secondary forests with dense undergrowth have cropped up. In some areas repeated destruction of the forest by man has given rise to grassland savanna. The study site is traversed by many streams and a few rivers.

Subjects and Methods

The subjects were 840 pupils of classes 3, 5 and 7 (age range 5 – 16 years) attending 17 primary schools in Kumba Health District. The informed consent of both the subjects and their parents/guardians was obtained to select children for the study.

Questionnaire Survey

The questionnaire used was adapted from that proposed by Lengeler *et al.* [9] for schistosomiasis. It was administered by the class teacher to the children whose parents had given their consent for blood samples to be collected from them for laboratory studies. Each class teacher asked the pupils whether during the previous two weeks, they had experienced any of a number of listed symptoms and diseases, amongst which were headache, fever, pains of the body and joints, diarrhoea, shivering, chills, vomiting and malaria. The teachers recorded the children's responses as "yes", or "no" or "don't know" (counted as "no" in the evaluation). The prevalence of positive answers for malaria-related symptoms and malaria per school were calculated. The number of true and false positives as well as true and false negatives were determined for malaria and each symptom, using prevalence of malaria by microscopic examination as standard.

Microscopy

Non-coagulated blood samples were collected from the children to whom the questionnaires had been administered. Thick blood films were made and stained with Giemsa for the identification and quantification of malaria parasites.

The prevalence of malaria and its associated symptoms determined from the questionnaire survey were compared with the results from microscopic examination using chi square test. The correlation between disease prevalence rates from microscopic examination and the questionnaire positivity rates for the disease or disease-related morbidity was determined by Spearman's Rank Correlation.

Results

The data on prevalence of malaria obtained by questionnaire survey and microscopic examination are presented in Table 1. Microscopic examination revealed an overall malaria prevalence rate of 41.4% as against 23.9% by questionnaire survey. The difference was very significant (P<0.001).

Table 1: Prevalence of malaria and its associated symptoms

School	Prevalence rate (%)								
	Headache	Fever	Joint and Body pains	Diarrhoea	Vomiting	Shivering	Chills	Malaria (Questionnaire)	Malaria (Microscopy)
G.S. Ediki	44.2	57.1	45.5	28.6	22.1	31.2	33.8	16.9	47.4
G.S. Mbal.	51.8	46.4	51.8	28.6	25.0	37.5	51.8	34.5	30.4
CPS Bai Foe	46.0	72.0	18.0	12.0	20.0	8.0	44.0	18.0	28.6
G.S. Foe Bak.	74.3	65.7	45.7	45.7	31.4	40.0	60.0	28.6	16.7
G.S. Kuke M.	59.4	46.9	21.9	0.0	12.5	21.9	31.3	21.9	55.2
P.S. BaromK.	83.3	76.2	50.0	38.1	26.2	47.6	52.4	26.2	69.2
G.S. NewTB	50.0	60.0	20.0	40.0	40.0	30.0	60.0	40.0	42.9
G.S. Bai Panya	72.0	48.0	28.0	28.0	32.0	36.0	32.0	8.0	75.0
Saker CBC Sc.	61.6	51.2	32.6	9.3	40.7	14.0	54.7	22.1	36.4
St. Anth.CS	38.7	48.4	22.6	6.5	29.0	29.0	35.5	19.4	43.9
GBPS Kum.	42.3	30.8	23.1	0.0	19.2	7.7	3.8	11.5	37.6
G.S. Barom.K.	66.0	68.1	38.3	25.5	44.7	38.3	48.9	57.4	45.2
GBPS Kumb.Stn	56.4	43.6	33.3	17.9	23.1	0	5.1	38.5	47.2
St JPr Schl	31.9	29.8	19.1	8.5	12.8	4.3	6.4	23.4	26.1
HRC Laduma	65.4	61.5	34.6	26.9	50.0	46.2	69.2	19.2	11.5
G.S. Teke	26.7	37.8	24.4	13.3	24.4	11.0	4.4	20.0	61.4
CBC BetPull	46.7	48.9	22.2	6.7	22.2	17.8	22.2	11.1	27.9
Total Population	53.6	53.0	33.0	19.8	27.9	24.3	36.7	23.9	41.4

Table 2: Validity of the questionnaire screening tests for malaria

Screening test	Validity of screening test*			
	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Headache	54.4%	47.5%	42.4%	59.4%
Fever	56.7%	47.8%	43.3%	61.0%
Body & Joint pains	36.0%	68.7%	44.7%	60.4%
Diarrhoea	21.3%	81.2%	44.5%	59.3%
Shivering	22.4%	74.4%	38.5%	57.4%
Chills	34.1%	61.6%	38.8%	56.7%
Vomiting	26.5%	73.6%	41.1%	59.1%
Malaria (questionnaire)	25.8%	75.5%	42.4%	59.2%

*Standard technique : Microscopic examination.

Of all the malaria-related symptoms investigated, headache and fever gave similar rates in most cases (with mean rates of 53.6% and 53.0% respectively), but their values were generally higher and significantly different ($P<0.001$) from the prevalence of malaria determined by microscopic examination (Table 1). The prevalence rates of joint and body pains, shivering, vomiting and diarrhoea greatly underestimated the prevalence of malaria ($P<0.001$). There was no significant correlation between the prevalence rates obtained by questionnaire (for malaria or its associated symptoms) and the prevalence values for malaria determined by microscopic examination.

Table 2 shows the sensitivity and specificity of the various malaria-related symptoms as screening tests for malaria. The results reveal clearly that even though headache and fever gave similar prevalence rates, the screening tests for both parameters proved to be of low sensitivity and specificity in detecting the disease. The microscopic method of determining the presence or absence of malaria infection was used here as the standard diagnostic method against which the accuracy of the screening tests was determined. The positive and negative predictive values were equally low, corresponding to the low sensitivity and specificity of the tests.

Discussion

The high prevalence rate of malaria in the Kumba Health District (41.4%) is understandable, especially as the high temperatures, rainfall and humidity tended to favour the breeding of the vector, *Anopheles* mosquitoes, and hence the transmission of malaria. The high prevalence rate is also a reflection of the abundance of mosquito breeding sites (standing pools of water, standing water in cut cocoa pods, plantain and cocoyam axiles, water in pot holes, etc). Since the children diagnosed by microscopic examination as infected were those present in class on the day of sample collection, it would appear that the comparatively low prevalence rate (23.9%) determined by questionnaire survey was an indication that most of the cases diagnosed by microscopy were asymptomatic. Since malaria in highly endemic in most parts of Africa [10], people are infected and re-infected so frequently that they develop a degree of acquired immunity. Consequently, such persons become asymptomatic or mildly symptomatic [11].

There is considerable overlap of signs and symptoms of malaria and various other diseases, including helminthic infections (schistosomiasis, taeniasis and paragonimiasis), viral infections (measles, mumps, viral meningitis, poliomyelitis, viral hepatitis and influenza) and bacterial infections (bacterial pneumonias, streptococcal infections, typhoid and paratyphoid fever, salmonellosis, cholera and bacterial meningitis) [12, 13]. However, a combination of symptoms and signs, including a rapid rise in temperature with subsequent perspiration, splenomegaly and regular intermittent fever with alternations of paroxysms in one or two days, show some specificity for a malaria diagnosis [13]. Combinations of the symptoms investigated in our survey did not prove useful for malaria diagnosis.

Studies carried out in Congo [14] and the Philippines [15] showed that high fever is a useful predictor of malaria. However, clinical malaria is rare (especially in adults) in areas of high endemicity as a result of acquired immunity, hence the significant number of asymptomatic cases which cannot be detected by questionnaire.

In rural areas, most malaria therapy occurs outside official health care systems through self medication with traditional medicine. Such treatment in most cases is ineffective. Clinical diagnosis of malaria is therefore rarely confirmed by microscopic examination, yet prompt accurate diagnosis is needed for effective treatment. Clearly the results of the questionnaire survey obtained in our study have demonstrated the inefficiency of this method as a rapid screening test for malaria.

Laboratory diagnosis by microscopy remains the most accessible and reliable diagnostic procedure that can be employed at the various health care units in a malaria endemic region.

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