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MALARIA AND INTESTINAL HELMINTHIASIS IN SCHOOL CHILDREN OF KUMBA URBAN AREA, CAMEROON

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ABSTRACT

Background: **Malaria and intestinal helminthiasis are parasitic diseases causing high morbidity and mortality in most tropical parts of the world, where climatic conditions and sanitation practices favour their prevalence. These infections do co-exist and have different effects on infected individuals.**

Objectives: **To assess the level of endemicity of malaria and helminth infections in school children of the Kumba Urban Area of Cameroon, and to determine how these infections relate to each other.**

Design: **Cross sectional study.**

Setting: **Four primary schools in the Kumba urban area.**

Subjects: **Two hundred and forty three randomly selected pupils aged four and fifteen years of both sexes.**

Results: **All two hundred and forty three pupils had malaria parasites in their blood. The geometric mean parasite load was 1282 parasites per µl of blood. Only 17 pupils were anaemic (PCV<30%). The helminth infections showed a 38.3% prevalence, with a geometric mean parasite load of 687 eggs per gram of faeces. Co-infections were recorded in 38.3% of the pupils. There was no significant correlation between the helminth and malaria parasite densities (r=0.04, P=0.7337).**

Conclusion: **Both malaria and helminth parasites do co-exist without clinical symptoms of infection in school children of the Kumbi Urban Area.**

INTRODUCTION

Malaria and intestinal helminthiasis are parasitic infectious diseases causing high morbidity and mortality in most parts of the world, particularly in the tropics where climatic conditions and sanitation practices favour their high prevalence(1). Four Pasmodia species namely, *Plasmodium falciparum* , *P. malariae, P. ovale* and *P. vivax* cause malaria in man. In some endemic regions it is common to find two, three or even four species in one individual. Intestinal helminthiasis on the other hand is caused by the soil-transmitted nematodes *Ascari lumbricoides, Trichuris trichiura* and the hookworms *(Necator americanus* and *Ancylostoma duodenale). Trichuris* and *Ascaris* are generally co-extensive in distribution, and infections are often present concurrently(2). Thus, mixed infections with two or three species of helminths are common, endemic areas.

In Cameroon malaria is endemic with pregnant women, infants, non-immune adults travellers particularly at risk of infection. In the South West Province of Cameroon, and in the Kumba Health District in particular, malaria is highly endemic and is ranked as the most important disease problem here, with the rural population having a higher prevalence than people in the urban area. Helminth infections are also endemic in the Kumba Health District and transmission of infection occurs throughout the year, with children in the rural areas showing higher levels of infection those in the urban areas(4).

Studies carried out by several workers have indicated that helminths co-exist with malaria and have different effects on the infected individuals. Roberts and Janovy(2) observed that hookworm disease is usually manifested in the presence of malnutrition and is often complicated by infection with other worms and/ or malaria. Nacher *et al*(5) in Thailand indicated that pre-existing helminth infections might increase the severity of malaria anaemia, thus increasing the likelihood of carrying gametocytes. In another study Nacher *et al*(6) showed that helminth infections are associated with protection from cerebral malaria and renal failure. They found that helminth infected patients were less likely to have jaundice or circulating high numbers of peripheral mature schizonts. These protective tendencies of helminth infections reflect a mutual equilibrium between some of the most widespread human parasites. As such, helminth infected patients are able to tolerate high malaria parasite densities, without any serious manifestations, although patients may become very anaemic and act as a source of gametocytes to mosquitoes for further transmission.

The Kumba Health District is characterised by climatic and human behavioural conditions which favour the prevalence of both infections(3). The present study was designed to assess the current level of endemicity of malaria and intestinal helminth infections in the Kumba Urban Area, and to determine how these infections relate with and influence each other.

MATERIALS AND METHODS

Study area: The study site was the Kumba Urban Area located in the Kumba Health District the South West Province of Cameroon. The Health District is characterised by a few rivers, many streams, poor roads, houses cramped up along the motorable roads, poorly disposed garbage, mudy pools and poor drainage systems. Cocoa, plantains, fruit trees and coffee are the main cash crops and these are commonly grown around homes or in nearby farms. The area is also characterised by high temperatures and humidity, a long rainy season from mid- March to mid- November with heavy rainfall, and a dry season from mid-November to mid-March. The inhabitants are mostly subsistence farmers, with a few being traders. Most families lack piped water, but many have wells in their compounds from which they collect water for drinking and domestic activities. These wells are poorly maintained and so serve as breeding grounds for mosquitoes, encouraging transmission of malaria parasites. The wells are exposed to contamination by improperly disposed human faeces, which may seed them with helminth eggs.

In the Kumba Urban Area, the situation seems to be even worse because houses are more cramped up than in the rural areas. The number and amount of waste dumps along the streams and around the town is large and heavy. The drainage system is poor. All these factors help to increase the rate of contamination and transmission of these infections.

Study subjects: Two hundred and forty-three randomly selected pupils, aged between 4 and 15 years of both sexes, attending classes three, five and seven in four primary schools (St. Anthony School C.B.C Saker, Sacred Heart School and St. Therese School Fiango) of the Kumba Urban Area, participated in the study. The informed consent of the parents or legal guardians of each child was obtained prior to commencement of the study. Sample collection was carried out in April and May 2002.

Methodology: Blood samples were collected from the pupils by finger prick and used for the determination of anaemia and identification of malaria parasites. Anaemia was assessed using packed cell volume (PCV), the values of which were read using the haematocrit reader. Pupils with PC levels below 30.0% were considered anaemic and those with PCV levels of 30.0% and above we considered normal(7). Thick and thin blood films stained with Giemsa stain were examined for identification and quantification of malaria parasites.

The Kato-Katz thick smear technique was used for the quantitative estimation of helminth eggs in stool(8). The intensity of infection was expressed as the number of eggs per gram of faeces (epg faeces).

Statistical analysis: Chi-square test was used to compare the prevalence of infections. The Student's T-test or analysis of variance was used where appropriate to compare means. The Pearson's correlation was used to determine the correlation between the intensities of infection of malaria and helminths. To obtain the geometric means, a $\log_{10}$ transformation of helminth egg counts and malaria parasitaemia was done for all positive samples. The results were considered to be significant at 5% probability level ($P < 0.05$).

RESULTS

Prevalence of malaria parasitaemia and density: All 243 pupils examined had malaria parasites in their blood stream, with a mean parasite density (geometric mean) of 1282 and a range of 40-64000 parasites per µl of blood (Table 1). The mean parasite density of the males (1362) was higher than that of the females (1229). It decreased with increase in age and class of pupils. These differences were however, not significant. The majority of infected individuals (73.7%) carried a parasite load of between 501 and 5000 per µl of blood, followed by those harbouring ≤ 500 parasites per µl of blood (18.6%), and least by those with >5000 parasites per µl of blood (7.8%). The differences were very significant ($P < 0.0005$).

At least 64/243 (26.3%) pupils had a high load of gametocytes, 20/243 (8.2%) had schizont and 13/243 (5.3%) had merozoites with very low parasitaemia in their blood.

Table 1

Malaria parasitaemia as influenced by sex, age and class of pupils

Description		No. of pupils examined	Parasitaemia (parasites per µl of blood) Geometric mean	Range
Sex	Males	98	1362	80-64000
	Females	145	1229	40-15750
Age (years)	≤ 5	12	9948	119-4800
	6-10	144	1380	79-56092
	11-15	87	1148	40-64000
Class	3	106	1475	80-25385
	5	75	1192	79-12305
	7	62	1101	40-64000
Overall		243	1282	40-64000

Table 2

Relationship between malaria parasite density and anaemia (PCV level) in school pupils

PCV Level	No. of pupils	(%)	PVC (%) Mean + SEM	Range	Parasitaemia (parasites per μl of blood) Geometric Mean	Range
<30%(anaemic)	17	7.0	28±1.0	26-29	1265	160-4800
>30%(non-anaemic)	225	93.0	35.5±3.3	30-47	1386	40-64000
Overall	242	10	34.95±7.1	26-47	1282	40-64000

SEM= Standard error of mean

Table 3

Prevalence and intensity of infection of soil-transmitted nematodes in pupils of the Kumba Urban Area as affected by sex, age and class of pupils

Description		No. of pupils	Prevalence of infection		Intensity of infection (epg faeces)	
			No. infected	(%)	Geometric mean	Range
Sex	Males	98	36	36.7	704	48-21688
	Females	145	57	39.3	676	24-226756
Age(years)	≤5	12	6	50.0	1098	384-5040
	6-10	144	53	36.8	613	24-12360
	11-15	87	34	39	756	96-22656
Class	3	106	42	39.6	538	24-11040
	5	75	27	36	`382	96-22656
	7	62	24	38.7	479	96-8616
Overall		243	93	38.3	687	24-22656

Epg= Eggs per g of faeces

Table 4

Prevalence of malaria/helminth co-infections in pupils of the Kumba Urban Area as affected by sex, age and class of pupils

Species Combination	% Prevalence of malaria/helminth co-infections Sex: Male (n=98)	Female (n=145)	Age groups (years): ≤5 (n=12)	6-10 (n=144)	11-15 (n=87)	Class: 3 (n=106)	5 (n=75)	7 (n=62)	Overall % Prevalence (n=243)
Malaria/Ascaris	27.6	25.5	50.0	24.3	26.4	28.3	26	21	26.3
Malaria/Trichuris	18.4	21.4	33.3	17.4	23	18.9	17.3	25.8	20.2
Malaria/ hookworms	20.4	13.8	25.0	13.9	19.5	6	13.3	21.0	16.5
Malaria/Ascaris Trichuris	5.1	7.6	25.0	5.6	5.7	8.5	6.7	3.2	6.6
Malaria/Ascaris Hookworms	5.1	3.4	16.7	2.8	4.6	4.7	5.3	1.6	4.1
Malaria/Ascaris Trichuris hookworms	4.1	3.4	0.0	2.1	6.9	2.8	1.3	8.1	3.7
Malaria/ Ascaris Trichuris Hookworms	7.1	4.1	0.3	4.9	5.7	4.7	5.3	6.5	5.3
Malaria helminths	36.7	39.3	50.0	36.8	39.1	39.6	36.0	33.7	38.3

The influence of parasite density on anaemia: The PCV levels determined for 242 pupils revealed mean ± SEM value of 35.0 ± 3.7%, with a range of 26 - 47% (Table 2). Seventeen (7.0%) pupils had mild anaemia, with PCV values <30% (mean ± SEM of 28.1 ± 1.0 and a range of 26 - 29%). On the other hand, 225/242 (93.0%) pupils were non - anaemic with PCV values ≥30%(Mean ± SEM of 35.4±3.9 and a range of 30 - 47%). There was a very significant difference in the mean PCV value between anaemic and non-anaemic cases (P<0.0001). The geometric mean parasite count for anaemic cases was 1265 (range of 160 - 4800) parasites per µl of blood, and this was lower than the mean parasite count of 1386 for normal cases (range of 40 - 64000), but the difference was not significant.

Prevalence and intensity of helminth infections: Out of the 243 pupils examined, 93 (38.3%) of them were infected with helminths (Table 3). Females showed a higher prevalence than males. Pupils ≤5 years old and class three pupils showed the highest prevalence. The differences were, however, not significant. The results presented in Table 3 also indicate that the helminth-infected pupils had a geometric mean parasite density of 687 (range of 24 - 2265) eggs per gram of faeces. Males had a higher egg load than females. Pupils aged ≤ 5 years showed the highest intensity of infection while 6-10 years old pupils showed the least. The differences in infection with respect to sex and age of pupipls were not significant. It should be noted, however, that the number of pupils in the ≤5 years age group was small and therefore the results obtained were not conclusive. There was a significant difference in the intensity of infection between children of different classes, with class 5 pupils carrying the highest geometric mean egg count (P<0.01).

Species of malaria parasites and helminths diagnosed in the school children: Four *Plasmodium* species were diagnosed in this study population. Of the 243 pupils infected with these parasites, 49(20.2%) had a single infection while 194 (79.8%) had mixed infections with two, three or four species *Plasmodia P. falciparum* was the most prevalent (99.6%) in the study population, followed by *P. malariae* (57.2%), *P. ovale* (39.1%) and least by undetermined species (34.6). The difference in prevelance between the four species was highly significant (p<0.0001).

The species of helminths identified were *Ascaris lumbricoides, Trichuris trichiura* and hookworms. Of the 93 pupils infected with helminths, 45 (48.4%) had a single infection while 48 (51.6%) had mixed infections with two or three species of helminths. *Ascaris* infections showed the highest prevalence (26.3%) in the study population, followed *by Trichuris* infections (20.2%), and least by hookworm infections (16.5%) (Fig. 1). The difference in prevalence between the various helminth species was very significant (P < 0.005).

Malaria/helminthiasis co-infection: All 93 pupils infected with helminths also had malaria parasite in their blood, giving a prevalence of co-infection in the study population of 38.3% (Table 4). There was no significant correlation between the helminth and malaria parasite densities (r = 0.04, P=0.7337). Out of the 243 pupils examined, 64 (26.3%) had *malarial/Ascaris* co-infection, 49 (20.2%) had *malarial/Trichuris* co-infection, and 40 (16.5%) had malaria/hookworm co-infection. The mean malaria parasite density of those having the co-infections was 1528 (range 119 - 64000) parasites per µl of blood, compared to 1148 (range 40 - 13918) parasites per µl of blood for those without worms. These differences were however not significant

The prevalence of malaria/helminth species co-infections (Table 4) followed the same general pattern as that of helminth species infections (Table 3). Generally, females showed a higher rate of the co-infection (39.3%) than males (36.7%), while pupils ≤5 years old showed the highest prevalence (50%) compared to pupils of the other age groups. However, these differences were not significant.

Malaria/helminthiasis co-infection and anaemia: Out of the 17 anaemic cases identified in the study population, 11(64.7%) had malaria/helminthiasis co-infections. On the other hand, of the 225 non-anaemic cases, 82(36.4%) had malaria/helminthiasis co-infections. Thus, there was a significantly higher proportion of co-infections among anaemic pupils than among non-anaemic individuals (P<0.05). Among the 17 anaemic cases, 9(52.9%) had *Ascaris,* 6(35.3%) had hookworm and 3(17.6%) had *Trichuris* infections. Five of these cases were mixed infections involving two or three helminth species. The geometric mean egg counts per gram of faeces were 1920, 337 and 75 for *Ascaris* hookworm and *Trichuris* respectively. The mean malaria parasite density of anaemic cases with co-infections was 1218 parasites per µl of blood, and this was lower than that of non-anaemic cases (1560) parasites per µl of blood) with co-infections, but the difference was not significant. The correlation of the malaria parasite density of anaemic versus non-anaemic pupils infected with worms was positive but insignificant (r=0.09, P=0.8035). The mean helminth parasite density of anaemic cases (1268 epg faeces) was higher than that of non-anaemic cases (633 epg faeces), but the difference was also insignificant.

DISCUSSION

This study was carried out in April and May, which is a period of high rainfall, high temperatures and humidity. During this period the rains provide habitats for breeding and the temperatures favour rapid growth and development of the *Anopheles* mosquito vectors. The presence of many potholes, the large number of wells within the town, the large number of dirt dumps, and the presence of crops like plantains, bananas, maize and cocoyams planted around dwelling houses and schools, provided many breeding sites for the *Anopheles* mosquito vectors. All these factors probably led to an increase in the transmission rate of the disease in the town, and hence the high endemicity observed in the Kumba Urban Area. Achidi *et al*(9) observed the malaria transmission, morbidity and mortality rates are highest during the rains. During this period it may suddenly break out as an epidemic, and then remain endemic at very high levels thereafter. Since our work was a cross-sectional study, it is not certain whether the disease remains highly endemic throughout the year or not.

In this study, all pupils examined were asymptomatic for malaria and 92.2% of them carried parasitaemias ≤ 5000 parasites per µl of blood. This confirms studies done by Biemba, *et al*(10) who reported that in highly endemic areas where there are constant repeated transmissions and infections, a low-grade asymptomatic parasite load remains the common phenomenon rather than the exception. Achidi, *et al*(11) had observed that people living in highly endemic areas may carry high loads of asymptomatic parasites in their blood streams after surviving a primary attack. This implies that although the level of parasitaemia may be high, hosts who have been exposed to several malaria infections before may be able to tolerate high loads on parasites and yet remain asymptomatic with their high circulating parasitaemic levels. These toleran carriers in a population are epidemiologically very important as they serve as reservoirs and thus source of infection to persons around them, making the area remain highly endemic.

In this study, males showed higher parasite loads than females, although the difference was not significant. This agrees with earlier studies(1,3) which attributed this to sex differences in social behaviour. It was also observed in our study that malaria parasite load decreased with increase in age and class of pupils, although the decrease was not significant. It is probably that being in an endemic zone, the pupils have had repeated exposures and infections over the years, and have developed some protective immunity(2,11). To have been able to tolerate a parasite load while remaining asymptomatic implies that the older exposed children were beginning to resist super-infections(2), which lowered their parasite load. The younger children had higher parasite loads, although asymptomatic, indicating that they are still in the process of acquiring protective immunity to re-infections and super-infection and are at this point in time probably undergoing a period of clinical protection while undergoing active immunisation which protects them against severe disease(12). Thus, children who have been exposed to a variety of constantly changing infections under high intensities of transmission are asymptomatically infected at any one time throughout their childhood, often with multiple parasite populations, acquired continuously throughout the year(12).

The non-anaemic group of pupils (PCV≥30%) had a higher geometric mean of mala parasitaemia (1386) than the anaemic group (1265) (Table 2). This would seem to suggest that it is not only the number of parasites observed in stained blood films from peripheral blood that determined who was anaemic and, consequently, the pathological status of the individual, but also the type of species of the parasite involved. *P. falciparum* is noted to cause mass destruction of red blood cells and sequestration, this was the most prevalent species found in the study.

It was observed in our study that 26.3% of the pupils carried very heavy loads of gametocytes. The gametocyte is the form in which the malaria parasite is transmitted from the vertebrate host to the mosquito vector, and an increase in their incidence would be expected to have a corresponding impact on the prevalence of malaria, particularly in areas of high transmission(13).

Intestinal helminth infections have been identified as a major cause of morbidity in school children worldwide, but mostly in developing countries(14). The environmental conditions, such a high temperatures and humidity, alongside poor hygienic and farming practices, favour the development and continuous transmission of these helminths.

In this study it was observed that more females carried soil-transmitted helminth infections than males, although males had heavier egg counts than females. Behnke *et al*(15) also observed that males usually carry and pass out heavier egg load than females. This might probably be due to their different behavioural activities(4), boys playing more than the girls during the break period in school and after school, and thereafter would proceed to eat without washing their hands. Behnke *et al*(15) also stated that worm burdens are neither uniformly nor randomly distributed, but are over-dispersed, with a few of the pupils carrying disproportionately large worm burdens. Hall(16) also observed that hosts tend to be infected for long periods of time with slowly fluctuating numbers of worms, and that even if all children in a community are infected, the majority are usually lightly infected.

This study showed that *Ascaris* infections were the most prevalent, followed by *Trichur* infections and least by hookworm infections. This pattern is similar to the observation of Ndamukong *et al*(4) in the Kumba Health District. *Ascaris lumbricoides* has been found world wide to be the most common and most infectious (probably due to the resistant nature of the ova to destruction) of all the helminths. These infections are usually clinically asymptomatic and cause reversible deficits in growth, physical fitness and cognitive function in children(17), with serious complications only occurring during heavy infections(2). The findings in this study confirm others elsewhere, that helminth infections show an age dependent pattern of infection.

Ascaris and *Trichuris* infections react their peak prevalence rates in children before the age of five years, with maximum burdens occurring in children five to ten years of age while hookworm infections reach their peak in young adults(17).

It is a common phenomenon in many endemic areas of the world where conditions favour the prevalence of both malaria and helminth parasites to find individuals carrying the malaria/helminth parasite co-infections in them(1). These co-infections tend to have different effects on the infected individuals(2). The mean malaria parasite density of pupils with co-infections was moderate and showed a positive, though insignificant, correlation with worm load. This implies that an increase in worm load may influence a corresponding increase in intensity of malaria infection. Nacher *et al*(5) observed that helminth infections increase the likelihood of malaria-infected patients resorting to more gametocyte formation, thus increasing the carrying capacity of gametocytes in the individual, and hence the chances of transmission of these malaria parasites by the mosquito vector to other people in endemic areas. Nacher *et al*(6) also found that helminth infected malaria patients had fewer circulating mature schizonts than non-helminth malaria infected patients. These helminth-infected patients were likely to be protected from cytoadherence or sequestration and obstructive jaundice, and so could not develop cerebral malaria and renal failures. In this study, only 8.2% of the pupils carried observable schizonts, implying that most of the pupils with the co-infections could have been protected from having any severe disease. As such they remained, and were seen as asymptomatic, although the carried high loads of malaria parasites and worms.

In our study population, 64.7% of the pupils with anaemia carried malarial/helminth co-infections. It is possible that the presence of helminths could have aggravated the anaemic situation in these malaria-infected pupils, since the helminths feed on food and blood in the intestines while there is usually mass destruction of infected and non-infected erythrocytes in malaria infection.

It may be concluded from this study that both malaria and helminth parasites do co-exist in school children of the Kumba Urban Area without any clinical symptoms of disease. Conditions, both environmental and man-made, exist in the study area which favour the transmission of these parasites. Educating the inhabitants in this area on the consequences of proper or improper treatment of these infections will be the best and primary control measure to apply.

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