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INFLUENCE OF URBANISATION ON ASYMPTOMATIC MALARIA IN SCHOOL CHILDREN IN MOLYKO, SOUTH WEST CAMEROON

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ABSTRACT

Objective: **To determine the impact of urbanisation on the prevalence of asymptomatic malaria in Molyko, a rapidly urbanising area of South West Cameroon.**
Design: **A cross-sectional study.**
Setting: **Molyko, South West Province Cameroon.**
Subjects: **One hundred and sixty six and two hundred and forty four randomly selected children in Molyko in the rainy seasons of 2000 and 2004 respectively.**
Main outcome measures: **Prevalence and geometric mean parasite density of asymptomatic malaria, measurement of axillary temperatures and haematocrit (PCV) values in 2000 and 2004.**
Results: **There was a significant association between axillary temperature and malaria parasitaemia in both years ($p<0.05$). Overall, the prevalence of asymptomatic malaria and parasite density values in all age groups in 2004 were lower than in 2000 while the reverse was the case with PCV values.**
Conclusion: **Urbanisation in Molyko has likely reduced the level of malaria endemicity in the area. It is advisable to repeat this study over a period of time in order to assess the long-term effects of urbanisation in the study area.**

INTRODUCTION

It is estimated that 400-600 million cases of malaria occur every year with up to three million deaths and the majority of these cases are in African children under the age of five years and pregnant women (1). An estimated 200 million people live in urban malaria endemic areas in Africa (2) and a high proportion of clinical admissions in these areas are treated as malaria. The rapid increase in the world's urban population has major implications for the transmission and epidemiology of malaria as well as other vector-borne diseases (3-6). This situation is particularly true in sub-Saharan Africa, the most rapidly urbanising continent, with some of the highest rates of *P. falciparum* transmission (6,7).

Urban malaria poses a major challenge for health care systems in Africa. The heterogeneity in urban malaria patterns is driven by human activity, urban development and environmental determinants. The dynamics of urbanisation in sub-Saharan Africa greatly affect ecosystems and, hence population health and this is currently insufficiently documented (2-5). Epidemiological profiles and clinical patterns are known to vary between urban and rural environments (8,9). African urban populations are healthier and have reduced malaria transmission rates compared with rural counterparts and as a rule; cities are unhealthy for the malaria parasite due to pollution. Some recent reviews suggest that urban populations in Africa receive, fewer new infections from vectors compared with their rural counterparts (4,5,7,10,11).

Due to the fact that malaria is highly endemic in most parts of Africa, people develop a degree of immunity to the disease after repeated infections. These subjects are thought to be asymptomatic or mild symptomatic carriers (10,12). They, therefore, act as sources of the malaria parasites since there is nearly a permanent presence of very small numbers of parasites in the red blood cells of man (13,14), thereby causing massive destruction of red blood cells. Molyko in the South West Province of Cameroon is a rapidly urbanising town. The opening of the University of Buea in 1993 has led to massive movement of people into the area.

Although studies have been carried out on malaria in South West Cameroon (15-18) none has specifically focused on the impact of urbanisation on the prevalence of asymptomatic malaria. This work was therefore designed to examine the differences in prevalence of asymptomatic malaria in a rapidly urbanising area of South West Cameroon at different time points in order to explore the likely impact of urbanisation on malaria endemicity in the area.

MATERIALS AND METHODS

Study area: This study was carried out in Molyko, a rapidly urbanising town in the South West Province, Cameroon. The average air temperature is 25ºC, humidity above 80% and an annual rainfall of approximately 4000mm.There are two distinct seasons, a cold rainy season that extends from mid-March to October and a warm dry season that lasts from November to mid-March. Molyko is located at an altitude of 600m above sea level. In the year 2000 Molyko had a population of 11000 inhabitants and in 2004 the population was approximately 14,000 inhabitants (Delegation of Statistics, SWP, Buea). Molyko has witnessed rapid urbanisation in the last decade with the opening of the University of Buea, the only English-speaking university in Cameroon. A lot of houses have been constructed in the last decade to accommodate the growing population and a lot of social amenities now exist in the area thereby attracting a lot of people from different parts of the country.

Study population: The study population consisted of children aged 4 to 15 years of age and of both sexes attending Government Practicing School (GPS) Molyko. These were further divided into three age groups defined as 4 - 7, 8 - 11 and 12 -15 years' age groups. The school was visited in the rainy season (May, June and July), a period that coincides with the peak of malaria transmission, in the years 2000 and 2004. A series of meetings was held with teachers and schoolmasters to explain the purpose and methodology of the survey. Participation was voluntary and parents had to fill a questionnaire and sign the consent form. During each survey a total of 1000 informed consent forms were distributed to children inviting them to participate in the study. The form explained the aims of the study, procedures involved and the potential benefits (that is, those found positive for malaria would be treated). There were 253 and 338 positive responses with parental consent in 2000 and 2004 respectively. Only children who returned the consent forms had a blood sample taken and axillary temperature measured. However, some children were either absent or refused to be pricked on the day of sampling. Finally, 166 (80 boys and 86 girls) and 244 (126 boys and 118 girls) children were enrolled into the study in 2000 and 2004 respectively. An ethical clearance for the study was obtained from the District Medical Officer of the Buea Health District.

Field methods: A cross-sectional parasitaemia survey was carried out in the school in both years during the rainy season. Each child was sampled in school during school hours. A questionnaire was administered in English and exceptionally in Pidgin English when necessary. Children were interviewed with the assistance of school teachers regarding their socio-economic situation and malaria infection histories. Questions were asked about the type of house in which the pupil lived (cement brick or plank (wood) house; the type of conveniences used at home such as kitchen type (firewood or gas kitchen), television, video, toilet type and use of cars by parents etc. The social status was classified as poor (living in wooden houses without conveniences such as flush toilets and gas kitchens), middle (living in plank or block houses with flush toilets, gas kitchen and had television / video, no cars), and the rich (living in block houses with flush toilets, gas kitchens, television / video and cars) classes.

Clinical assessment and laboratory methods: The axillary temperature of each child was measured using a clinical thermometer by a qualified laboratory technologist. Fever was defined as a temperature ≥37.5°C. Blood was collected by pricking the finger using a sterile blood lancet and both thick and thin blood films were prepared on the same slide, stained with Giemsa stain and microscopically examined using the ×l00 (oil immersion) objective of the microscope. Based on the assumption that 8000 white blood cells are found in one ml of blood, parasite density in thick smears was defined as the number of parasites per 200 white blood cells. At least one hundred microscopic fields were observed before declaring a slide negative. The thin blood films from children found thick-smear positive were examined so that the *Plasmodium* species could be identified with the aid of identification tables of Cheesbrough (19). Blood from the puncture was also collected directly into a heparinised capillary tube for the assessment of packed cell volume (PVC). All the cases of malaria detected were treated with amodiaquine or quinine sulphate.

Blood filled heparinised capillary tubes were spun at 12,000g for five minutes in a microhaematocrit centrifuge (Hettich, Bach, Switzerland). Children were considered to be anaemic if PCV <31%, those with of PCV 21%-30%, 15%-20% and <15% being identified as mild, moderate and severe cases of anaemia, respectively.

Statistical analysis: The point prevalence rate was considered as the proportion of children screened at a particular point in time that had the malaria parasites in their blood. Differences in proportions were assessed using the Chi-square test. Comparison of sample means was done using analysis of variance (ANOVA). A P-value of <0.05 was considered indicative of a statistically significant difference.

RESULTS

Compliance and analysis of responses to questionnaire: In 2000, 166 children were examined and the mean age (± standard deviation) was 10.11 ± 2.45 years. Of the 166 children sampled, 67 (40.4%) gave a history of malaria in the previous one-month prior to the survey. The number of children who used preventive measures against malaria at home increased significantly from the year 2000 to 2004 (P<0.05) as shown in Table 1. The majority of the children from the poor class, 80.0% (16) and 76.9% (20) in 2000 and 2004 respectively were positive for malaria while none from the rich class had malaria (Table 1).

Table 1

Responses to variables recorded in the questionnaire

Variable	Positive responses	
	2000 (166%)	2004 (244%)
History of malaria in the previous one month	67 (40.36%)	80 (32.8%)
Treatment of malaria with:-		
Standard drugs from hospitals / drug store	55 / 67 (82.l%)*	66 / 80 (82.5%)*
Concoctions from herbs	12 / 67 (17.9%)*	14 / 80 (17.5%)*
Preventive measures:-		
Yes	50 (30.1%)	144 (59.0%)
No	116 (69.9%)	100 (41.0%)
Social status of parents:-		
Poor class	20 (12.0%)	26 (10.7%)
Middle Class	70 (68.1%)	170 (69.7%)
Rich class	33 (19.9%)	48 (19.7%)

$x^2 = 55$, p<0.005

* Percentages were calculated based on the number of children who gave a history of malaria and had treatment

The mean age of the children in 2004 was 9.63 ± 2.25 years. Overall 45.9% of the 244 children sampled in 2004 gave a history of malaria in the previous one-month prior to the study (Table 1). The presence of malaria was significantly associated with the social class of the pupil ($p<0.05$).

Relationship between axillary temperature and asymptomatic malaria: In 2000, a temperature of ≥37.5ºC was recorded in 66 (39.8%) of 166 children. Of the 66 pupils who had high temperatures, 50 (75.8%) of them were positive for malaria while 30 (30.0%) of those with normal temperatures also had malaria. In 2004 a total of 116 (47.5%) of 244 children presented with axillary temperatures of ≥37.5ºC and 74.2% of them were positive for malaria. There was a significantly higher proportion of individuals with high axillary temperatures that had malaria parasitaemia in both years ($p<0.00l$) as shown in Table 2 although there was no significant difference in those with pyrexia and parasitaemia between the years ($p < 0.05$).

Variation of malaria parasite prevalence and intensity with age and year in school children: Overall, there was a decrease in the prevalence rate of malaria from 48.2% in 2000 to 44.3% in 2004, although the difference was not significant ($p <0.05$). The highest values occurred in the 4-7 years age group and decreased steadily with age in both years. The geometric means decreased significantly from 2000 to 2004 ($p<0.05$) (Table 3). The overall geometric mean and range in 2000 was 1332 (30-59570) while in 2004 it was 691 (36-39976). Most of those positive for malaria had *P. falciparum* mono-infections and a few had mixed infections of *P. falciparum* and *P. malariae* or *P. falciparum* and *P. ovale* in both years.

Table 2

Relationship between axillary temperature and asymptomatic malaria in the years 2000 and 2004

	2000		2004	
Axillary temperature	No. positive for malaria (%)	No. negative for malaria (%)	No. positive for malaria (%)	No. negative for malaria (%)
<37.5ºC	30 (30.0)	70 (70.0)	24 (18.8)	104 (81.3)
≥37.5ºC	50 (75.8)	16 (24.2)	84 (72.4)	32 (27.6)
Total	80(48.2)	86(51.8)	108 (44.3)	136 (55.7)

$X^2 = 16.4$, P = 0.0001 $X^2 = 35.5$, P = 0.00

Table 3

Variation of malaria prevalence and intensity with age and year in school children

Year	Age group (years)	No. examined	No. positive (%)	GMPD* (Range)
2000	4-7	54	32 (59.3)	1231 (30-59570)
	8-11	48	27 (56.3)	1431 (36-43200)
	12-15	64	30 (46.9)	1038 (42-41105)
Total		166	89 (53.6)	1332 (30-59570)
2004	4-7	70	34 (48.6)	680 (36-39976)
	8-1 1	78	34 (43.6)	783 (40-39005)
	12-15	96	40 (41.7)	609 (38-34300)
Total		244	108 (44.3)	691 (36-39976)

Table 4

Malaria parasite density and anaemia in school children in different years

Year	Status of anaemia	No. of pupils	(%)	Mean PCV(range)	GMPD* (range)
2000	Anaemic (PCV<31%)	32	19.3	28.0 ± 2.3 (26-30)	1233 (80-63000)
	Non-anaemic (PCV<31%)	134	80.7	33.0 ± 0.0(33- 48)	1305 (40-64000)
	Overall	166	100	32.2 ± 1.8 (26-48)	1294 (40-64000)
2004	Anaemic (PCV<31%)	20	8.2	29.3 ±1.5 (27-30)	825 (33-34000)
	Non-anaemic (PCV<31%)	224	91.8	36.0 ±2.0 (32-48)	818 (38-43300)
	Overall	244	100	34.0 ±0.5 (27-48)	790 (33-43300)

GMPD* = Geometric mean parasite density (parasites per μl blood)

Malaria parasite density and anaemia in different years: Of the 166 pupils sampled in 2000 only 32 of them were anaemic with mean (± SD) PCV of 29.3 ± 1.5 (range 27-30) and geometric mean and (range) 1233 (80-63000). The majority of the anaemic cases had mild anaemia (15.1%) and the rest had moderate anaemia. Most of the anaemic cases were in the 4-7 years age group (Table 4).

In 2004, 20 (16.4%) out of the 244 pupils examined were anaemic and had a mean PCV of 28.0 ± 1.5 (range 26-30). There was a significant difference in the geometric mean parasite densities from the year 2000 to 2004 ($p<0.05$) (Table 4).

Prevalence of asymptomatic malaria by sex: Malaria was more prevalent in males (55.0% in 2000, 44.4% in 2004) than in the females (41.9% in 2000, 44.1 in 2004) in both years, but the difference was not significant ($p>0.05$).

DISCUSSION

This study was carried out during the rainy seasons of 2000 and 2004 and this period coincides with the peak transmission season of malaria in the study area (17). The study showed that there was a general decrease in the prevalence rates of pyrexia, asymptomatic malaria, anaemia and parasite density from the year 2000 to 2004. This agrees with reports from other African countries, which reported that rapid urbanisation is likely to reduce the frequency and transmission dynamics of malaria This in turn has significant effects on disease-associated morbidity and mortality, which consequently has important implications for control (2-4). At present, Molyko which was formerly a rural area is experiencing a very high rate of urbanisation-rapid construction of houses and roads, an increase in the number and quality of social amenities as well as an influx of people coming into the town from other parts of the country. The face of the town has changed considerably since the mid 1990s. Current estimates by the United Nations predict that rapidly urbanising areas in Africa will experience rapid population growth in contrast to rural areas due to strong rural-urban economically driven migrations with people seeking education and job opportunities outside subsistence farming (20). In the case of Molyko, the University of Buea, the only English-speaking university in Cameroon (with a high enrolment of over 10,000 students at the moment and staff strength of over 500) has played a major role in its rate of urbanisation.

The data in this study showed that there was a significant association between axillary temperature and asymptomatic malaria during both years. Nevertheless, cases of high temperatures (≥37.5ºC) without parasitaemia were also encountered.

This contradictory situation could probably be due to co-infections with other diseases, which were still at the asymptomatic stage. It is, therefore, difficult to say with certainty whether axillary temperature defines asymptomatic malaria since few children with normal temperatures (<37.5ºC) were also parasitaemic. However, we suggest temperatures of 37.5ºC and above as a possible predictor of fever (16) because the majority of children who were infected had axillary temperatures of 37.5ºC and above.

The high prevalence rate of *P. falciparum* observed is in conformity with earlier reports from Africa in general and some parts of Cameroon in particular, including Yaounde and Southwest Cameroon (18,22). They described *P. falciparum* as the most common cause of malaria infection. Most cases of malaria in the study areas are therefore caused by *P. falciparum*, and this can be very dangerous since it is the most pathogenic of all the *Plasmodium* species.

The fact that parasite density levels reduced significantly from the year 2000 to 2004 and that the prevalence rates of malaria were lower in 2004 than 2000 could likely be attributed to urbanisation in Molyko. Generally, studies show that compared with those living in rural areas, mothers and children living in urban communities have better nutritional status indicators; fewer morbid events; increased vaccine coverage; better physical access to health services; and greater use of insecticide-treated nets (ITNs) (2,21), screens on doors and windows and hence a reduction in the prevalence of vector-borne diseases including malaria. Other explanations include the fact that there is more pollution in urban areas and this affects larval habitats, the life cycle of mosquitoes and vectorial capacity. Higher human population densities may reduce biting rates owing to the higher ratio of humans to mosquitoes. This is likely to be the prevailing situation in Molyko at the moment.

An analysis of the responses in the questionnaire showed that the children from the poor class were more likely to have malaria than the others. Most of these children lived in plank houses, which most often have breaks, and crevices on the walls and these allow for easy passage of mosquitoes and consequently higher malaria prevalence. Nkuo-Akenji et *al* (23) showed that the prevalence of malaria was significantly higher in children living in plank houses than in those living in cement brick houses. In general, poorer populations which are more often found in rural areas are at greater risk of vector contact and infection, owing to physical proximity to water sources and lowered capacity (lack of education and resources) to use health care services and preventive measures to protect against malaria. Human-vector contact is influenced by housing type (for example, no screens on windows and doors), housing and roofing material and house location (gradient, surrounding drainage, and cleanliness of immediate environment). The use of screens, insecticides, prophylaxis and bed nets, which is a function of income and education. The majority of children from the poor class did not use any preventive measure at home. After using some of these intervention methods in Bolifamba, Nkuo-Akenji *et al* (24) reported that the prevalence of malaria reduced drastically a year later. Since 2003 there has been a lot of education over the radio, television and at clinics about malaria prevention and control in Cameroon. Most children under the age of five and pregnant women (groups at risk of the disease) have been receiving free insecticide treated bed nets especially in urban areas including Molyko. It would be interesting to note that most often the poor do not have, much access to this information as they hardly have radios and televisions and often resort to treatment of malaria with extracts from medicinal plants.

The significant decrease in anaemia prevalence and increase in mean PVC values in 2004 is an indication that urbanisation in Molyko has led to a better level of education and consequently better control methods in the study area. Anaemia is an inevitable consequence of malaria infection and malaria causes anaemia through haemolysis and increased splenic clearance of infected red blood cells and cytokine-induced dyseythropoeisis (25).

The slightly higher prevalence rate of malaria in boys might have been due to the fact that boys were more exposed to the vector, as they spend more time playing outdoors, a parameter, which was not investigated in this survey. Uko *et al* (12) also reported a slightly higher prevalence of asymptomatic malaria in men than in women in Calabar, Nigeria. Besides the activities that expose men to mosquito bites, their greater susceptibility is also alleged to be dependent on the male sex hormone-testosterone (12).

The lack of entomological data in the study design limits conclusive statements on the rate of transmission of the disease in the area. However Wanji *et al* (22) reported high entomological inoculation rates (EIR) of malaria vectors in this same region throughout the year with a peak during the rainy season. Since the year 2000 most vector breeding sites (in the form of bushes) have been destroyed and houses erected. Most of the added population to Molyko are educated people (majority are students) and keep their surroundings clean and use other preventive measures against malaria. Rainfall figures from the Cameroon Tea Estate showed that although rainfall values were lower in 2004 the difference was however insignificant. In

2005, Kimbi *et al* (18) also reported a high prevalence rate of malaria (98%) in children in the Muea area, a village four kilometres away from Molyko. This high prevalence in a village just four kilometres away from Molyko emphasises the fact that urbanisation might have contributed to a reduction in the prevalence rate of malaria. It is also possible that the lower prevalence in 2004 might be associated with changing ecological determinants of vector capacities resulting from urbanisation. This information is important for the National Malaria Epidemiology Board of Cameroon to be able to plan control strategies to alleviate the suffering of the people in this area from malaria. Currently, malaria control in urban African settings consists mainly of early diagnosis and prompt treatment, and the promotion of insecticide treated bed-nets. We propose that control programmes should include environmental management as a key feature for sustainable mitigation of the burden of malaria in Molyko and urban Africa as a whole.

In conclusion, the prevalence rate and parasite densities in all age groups were lower in 2004 than in 2000 while the reverse was the case with haematocrit values and this suggests that there might have been a reduction in the level of malaria endemicity from 2000 to 2004. Therefore urbanisation in Molyko might have led to the reduction of malaria endemicity in the area.

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