Malaria Control and Treatment Strategies among School Children in Semi-urban Tropical Communities

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ABSTRACT

Background: *Plasmodium infections among school children in Igbo-Eze South Local Government of Enugu State, Nigeria, were studied between July and December 2005. The relationship between the use of malaria control measures and the prevalence of Plasmodium infections was investigated.*

Methods: *Blood smears were obtained from 1296 school children (ages 4–15 years) from six schools randomly sampled from the study area. Drugs were given to infected children. Epidemiological questionnaires were administered to the children.*

Results: *Out of 1296 school children examined, 270 (20.8%) had* Plasmodium falciparum *infections. The prevalence of these parasitic infections varied significantly (*$p < 0.05$*) among schools, with Central School, Ovoko (30.1%* P falciparum*) and Community primary school, Itchi (13.9%), having the highest and lowest prevalence rates respectively. Furthermore, the prevalence of* P falciparum *infections also varied significantly (*$p < 0.05$*) among the age groups, with age groups 4 – 6 (35.1%) and 10–12 (14.2%) having the highest and lowest prevalence rates respectively. Males (23.1%) had a significantly higher prevalence rate than females (18.5%). The prevalence of malaria was significantly lower among pupils using preventive measures; 5.9% among pupils using mosquito bed net as against 21.2% among those not using bed nets and 4.6% for pupils living in screened houses as against 24.1% for those not living in screened houses.*

Conclusion: *The study revealed that malaria is a major public health problem among pupils in a Nigerian local community. Prevalence rates among pupils varied among location of schools, age and gender. Preventive measures favoured the use of bed nets and living in screened houses.*

Estrategias de Control y Tratamiento de la Malaria entre Escolares de Comunidades Tropicales Semiurbanas

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RESUMEN

Antecedentes: *Las infecciones por* Plasmodium *entre escolares de Igbo-Eze del Gobierno Local Sur del Estado de Enugu, Nigeria, fueron objeto de estudio entre julio y diciembre del 2005. Se investigó la relación entre la aplicación de medidas de control de la malaria y la prevalencia de infecciones por* Plasmodium.

Métodos: *Se obtuvieron frotis sanguíneos de 1296 escolares (4–15 años de edad) de seis escuelas, escogidas de manera aleatoria en el área de estudio. Se le dio medicamentos a los niños infectados. Se administraron encuestas epidemiológicas a los niños.*

Resultados: *De 1296 escolares examinados, 270 (20.8%) estaban infectados por* Plasmodium falciparum. *La prevalencia de estas infecciones parasitarias varió significativamente (*$p < 0.05$*) entre las escuelas, teniendo la Escuela Central, Ovoko (30.1%* P falciparum*) y la escuela primaria de la comunidad, Itchi (13.9%), las tasas de prevalencia más altas y más bajas respectivamente. Además, la prevalencia de infecciones por* P falciparum *también varió significativamente (*$p < 0.05$*) entre los grupos etarios, teniendo los grupos de edades 4–6 (35.1%) y 10–12 (14.2%) las tasas de prevalencia más alta y más baja respectivamente. Los varones (23.1%) tuvieron una tasa de prevalencia significativamente más alta que las hembras (18.5%). La prevalencia de malaria fue significativamente más*

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baja entre alumnos que aplicaron medidas preventivas: 5.9% entre alumnos que usaban mos-quitero, frente al 21.2% entre aquéllos que no usaban mosquiteros y 4.6% para alumnos que vivían en casas protegidas con malla metálica en las ventanas, frente al 24.1% para aquéllos que no vivían en casas protegidas con malla metálica.

Conclusión: *El estudio reveló que la malaria es uno de los mayores problemas de salud pública entre los alumnos en una comunidad local Nigeriana. Las tasas de prevalencia entre los alumnos varió con el lugar, la edad y el género. Las medidas preventivas favorecieron el uso de mosquiteros en los dormitorios y mallas metálicas en las casas.*

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INTRODUCTION

Malaria is a major public health problem with an estimated two million children worldwide dying of malaria yearly, primarily because of *Plasmodium falciparum* and its complications (1). The sub-Saharan African region has the greatest number of people exposed to malaria transmission and the highest malaria morbidity and mortality rates in the world (2). Malaria is known to have a negative impact on performance and learning in children (3). It also aggravates anaemia and malnutrition in children and pregnant women (4, 5). It is estimated that in Africa, malaria is responsible for over one million deaths yearly of infants and young children (6). The loss of the daily labour cost, coupled with cost of treatment and high mortality associated with the disease make malaria one of the main diseases retarding development in Africa (7). By adversely affecting people's health, strength and productivity, malaria further marginalizes and impoverishes them (8). In Nigeria, malaria is hyper-endemic with stable transmission (9).

In view of the negative socio-economic and health impact of malaria on children, there is a need for the development of good preventive and control measures adaptable to the tropics. Malaria control and treatment strategies among school children in Igbo-Eze South Local Government Area (LGA) are largely unreported. Thus, this study was carried out to estimate the prevalence of malarial parasite among school children in Igbo-Eze South LGA, Enugu State, Nigeria. Factors associated with lower prevalence rates were identified. It is hoped that the results of this study will be useful to both researchers and health authorities in diagnosis, planning and implementing control programmes for malaria in the area.

SUBJECTS AND METHODS

Study area

The study was carried out in Igbo-Eze South (LGA), Enugu State, Nigeria. The various communities in Igbo-Eze South LGA include Ibagwa-Aka, Iheakpu-Awka, Uhonowerre, Iheaka, Ovoko, Nkalagu Obukpa, Itchi, Alor-Agu and Unadu. The headquarters is at Ibagwa-Aka. There are three development councils in the area; Igbo-Eze South Central, Ekete and Udeze.

Igbo-Eze South LGA is located between latitudes $7^0 19^1$ East and $7^0 28^1$ East, and longitudes $7^0 00^1$ North and $6^0 53^1$ North (10). The area is in the guinea savannah forest mosaic zone of Nigeria. The study area has two main seasons: the rainy and dry seasons. The rainy season usually starts in April and ends in September. The dry season usually starts in October and ends in March. The inhabitants of this area are mainly subsistence farmers and traders. There are seventeen health centres in the area, with a General Hospital at Itchi. There are forty-four primary schools in the area. There are 14 994 pupils in the study area: 8860 males and 6134 females (11). The total population of people in the study area is 75 368 (12).

Selection of schools

Six schools were used for this study. Primary schools in the study area were listed and two schools were selected from each developmental council using random sampling technique. The schools selected for this study were Township School 1-Ibagwa, Community Primary School, 3-Itchi, Central School – Ovoko, Central School – Iheaka, Community Primary School 1-Unadu and Community Primary School – Iheakpu-Awka. Table of random numbers was used for the random sampling.

Collection and examination of blood samples

From each of the six schools selected, thirty-six pupils were selected and sampled using random sampling technique. Table of random numbers was again used for the random sampling. Six pupils were selected from each class (classes 1–6) to make up a total of 36. At the end of the exercise, the age and gender of the selected pupils were recorded. A total of 1296 pupils were sampled at the end of six months. Blood samples were collected monthly for a period of six months.

The finger of each pupil was cleaned using a swab moistened with 70% alcohol and allowed to dry. Thereafter, it was pricked using a sterile lancet. The finger was gently squeezed to obtain a small drop of blood which was smeared unto the slide to make a thin blood smear. A smooth edged spreader was used to spread the thin film. The slide was labelled with the date of collection and the pupil's name. The blood film was then air-dried with the slide in a horizontal position. After air-drying, the blood film was fixed with two drops of methyl alcohol for a minute. The alcohol was then tipped off and the film allowed to dry. Following drying, it was stained with Giemsa stain, placed in a rack and transferred to the laboratory for examination.

At the laboratory, a drop of immersion oil was applied to the thin film which was examined under the microscope using first, the 40 x objective followed by 100x objective to identify the *Plasmodium* species (13, 14). The number of pupils infected with *Plasmodium* and the type of *Plasmodium* species were recorded.

Post treatment monitoring

Infected pupils were treated with anti-malarial drug (Sulfadoxine-pyrimethamine – Loridox) at 10 mg/kg body weight. All drug administration was done by a trained Community Health Nurse. Post treatment samples were collected a month after treatment to examine the presence of *Plasmodium*. Treatment was said to be effective when *P falciparium* was not observed and ineffective when the parasite was observed during examination (13).

Malaria control monitoring

Responses of pupils from closed-ended questionnaire on the use of mosquito net and living in screened houses were correlated with the presence or absence of malaria parasitaemia.

Data analysis

Differences in the prevalence of infection between age and gender groups were determined using the χ^2 tests from the contingency tables. The analysis was done using the Epi-info database package (Centers for Disease Control and Prevention, Atlanta, GA) and SPSS (Statistical Package for Social Sciences) version 11.0.

RESULTS

Prevalence of *Plasmodium* infections among school children

The malaria parasite observed in this study was *P falciparium*. Of the 1296 school children examined for parasites, 270 (20.8%) were infected with *P falciparum.* Out of the 1296 school children examined, 216 were from each of the six different schools. Central School, Ovoko, had the highest prevalence (30.1%) of malaria (Table 1). There was significant difference in the prevalence of infections among the schools sampled ($p < 0.05$).

Age distribution and prevalence of *Plasmodium* infections

School children between the ages of 4–15 years were sampled. Children between the ages of 4–6 years had the highest prevalence of *Plasmodium* infections [35.1%] (Table 2). The differences in prevalence among the different age groups were statistically significant for *P falciparum* infection ($p < 0.05$).

Gender distribution and prevalence of *Plasmodium* infections

Of the 1296 school children sampled, 648 were males and 648 were females. The prevalence of *P falciparum* infections was significantly higher among males (150, 23.1%) than among females (120, 18.5 % $p < 0.05$).

Table 1: Prevalence of *Plasmodium* in the different schools sampled in Igbo-Eze South LGA, Enugu State

Schools	No. Examined	No. Positive	No. Negative	Prevalence (%)
Township School 1, Ibagwa	216	56	160	25.9
Community Primary School 3, Itchi	216	30	186	13.9
Central School, Ovoko	216	65	151	30.1
Central School, Iheaka	216	32	184	14.8
Community Primary School, Unadu	216	45	171	20.8
Community Primary School, Iheakpu-Awka	216	41	175	19.4
Total	**1296**	**269**	**1027**	**20.8**

Table 2: Age distribution and prevalence of *Plasmodium* infections among school children in Igbo-Eze South LGA, Enugu State

Age groups (in years)	No. Examined	No. Positive	No. Negative	Prevalence (%)
4–6	228	80	148	35.1
7–9	508	104	404	20.5
10–12	478	68	410	14.2
13–15	82	18	64	22.0
Total	**1296**	**270**	**1026**	**20.8**

No = number

Interaction between gender, age group and the prevalence of *Plasmodium* infections

The analysis of the interaction of gender, age group and the prevalence of *P falciparum* showed that males and females of age group 4–6 years had the highest prevalence of *P falciparum* infections (Table 3). However, the percentage of infected males (37.4%) was more than that of infected females (32.7%) (Table 3).

Table 3: Prevalence of *Plasmodium* infection among school children by age and gender in Igbo-Eze South LGA, Enugu State

Gender	Age groups (in years)	No. Examined	No. Positive	No. Negative	Prevalence (%)
Male	4–6	115	43	72	37.4
	7–9	248	61	187	24.6
	10–12	237	33	204	13.9
	13–15	48	13	35	27.1
Female	4–6	113	37	76	32.7
	7–9	260	43	217	16.5
	10–12	241	35	206	14.5
	13–15	34	5	29	14.7
Total		1296	270	1066	20.8

No = number

Effectiveness of Treatment

Out of the 270 (20.8%) malaria-positive children, treatment was effective for 63 (23.3%) children and not effective for 207 (76.7%).

Effectiveness of Malaria Control Measures

Malaria control measures used by school children in Igbo-Eze South LGA, Enugu state were mosquito bed nets and screening of windows and doors of houses with nets. Out of the 1296 school children sampled, 34 (2.6%) slept under mosquito bed nets while 1262 (97.4%) did not. Out of the 1262 that did not sleep under mosquito bed nets, 268 (21.2%) were positive for malaria while 994 (78.8%) were negative (Table 4). For the 34 that slept under mosquito bed nets, 2 (5.9%) were positive for malaria while 32 (94.1%) were not (Table 4). There was significant difference between the use of bed nets and the prevalence of malaria ($p < 0.05$).

Table 4: Effectiveness of malaria control measures used by school children in Igbo-Eze South LGA, Enugu State

Malaria Control Measures Used		*Plasmodium* infection Positive	Negative	Total
Use of mosquito bed nets	Yes	2 (5.9%)	32 (94.1%)	34 (2.6%)
	No	268 (21.2%)	994 (78.8%)	1262 (97.4%)
Screening of doors and windows of houses with mosquito nets	Yes	10 (4.6%)	209 (95.4%)	219 (16.9%)
	No	260 (24.1%)	817 (75.9%)	1077 (83.1%)

Of the 1296 school children sampled, 219 children had screens on the doors and windows of their houses with mosquito nets while 1077 did not. Out of 219 pupils that screened the doors and windows of their houses with mosquito nets, 10 (4.6%) were positive for malaria while 209 (95.4%) were not (Table 4). Of the 1077 pupils that did not screen the doors and windows of their houses with mosquito nets, 260 (24.1%) were positive for malaria while 817 (75.9%) were negative (Table 4). There was significant difference between the use of screened doors and windows of houses and the prevalence of malaria ($p < 0.05$).

It can be seen from Table 4 that the percentage of those that used mosquito bed nets and were positive for malaria (5.9%) was lower than those that did not use mosquito bed nets and were positive for malaria (21.2%). Table 4 also showed that the percentage of children that had screened their doors and windows with mosquito nets and were positive for malaria (4.6%) was lower than those that did not have screens on their doors and windows of their houses with mosquito nets and were positive for malaria (24.1%).

DISCUSSION

This study has shown the overall prevalence of *Plasmodium* (20.8%) infections (Table 1) among school children in Igbo-Eze South LGA, Enugu State. From this, it was seen that *Plasmodium* infection was prevalent. The reported prevalence of *Plasmodium* infections was high, indicating a high degree of malaria parasitaemia among school children in Igbo-Eze South LGA. This agreed with the previous work that reported 27% prevalence of malaria parasite among school children from a rural village in western Nigeria (15). Furthermore, our finding was lower when compared to 80% malarial parasite prevalence reported among school children in the malaria-endemic village of Erunmu in southwest Nigeria (16). The low prevalence of malaria in this study could be attributed to the location of the study area which lies in the guinea savannah-forest mosaic zone of Nigeria. This zone has lower rainfall compared to the tropical rainforest zone. Rainfall is known to increase the prevalence of malaria since it provides more breeding sites for the vector of malaria (17).

The present study revealed that the prevalence of *Plasmodium* in the different schools was generally high. *Plasmodium* infection was found to be more common in Central School, Ovoko, located in a semi-urban area. According to Crompton and Savioli, parasitic diseases persist in urban areas because of over-crowding and unhygienic conditions (18). There were significant differences in the prevalence of parasitic infections among the schools. The differences are probably a reflection of population densities. The differences in the different schools sampled could also be related to the local environmental factors inherent in the different schools' location.

In this study, it was found that children between the ages of 4 and 6 years had the highest prevalence of *Plasmodium* infections (Table 2) compared with the other age groups. This may be due to the fact that at that age, their immunity to parasitic infections has not been fully developed (19–21). This observation was in line with reported high prevalence of *Plasmodium* infections in younger children (6, 22). The prevalence of parasitic infections has been found to reduce with age (23). The prevalence of parasitic infections among the different age groups in the present study was significant ($p < 0.05$) indicating that the occurrences of these infections were age dependent.

Gender Distribution and Prevalence of *Plasmodium* Infections

The present study has shown that *Plasmodium* infections were more common in the male than in the female subjects. The present result conforms with the recorded higher prevalence of *Plasmodium* infection in male than in female school children in Ebonyi State, Nigeria (22). The higher prevalence of *Plasmodium* infection in males than in females may be attributed to the fact that males expose their bare

bodies more than females especially when the weather is hot and thus are more likely to be bitten by mosquitoes. Females, on the other hand, are usually not naked and tend to stay indoors, helping out with household chores. This reduces their contact with the mosquito vector (24). Also, studies have shown that females have better immunity to parasitic diseases and this was attributed to genetic and hormonal factors (24–25).

In this study, males of ages 4–6 years had the highest prevalence of malaria (Table 3). This may have been attributed to their young ages. It has been reported that *Plasmodium* infection was more prevalent in young children because of their relatively less developed immune systems (19, 20).

This study showed that treatment of *Plasmodium* infected school children with sulfadoxine-pyrimethamine tablets (IPCA) led to reduced prevalence of *Plasmodium* infection by 23.3%. Treatment failures recorded after one month in 76.7% of the children signals the need for close monitoring of the performance of the drug against re-infection of pupils by *Plasmodium* parasites in the area. Low efficacy of sulfadoxine-pyrimethamine drug against *Plasmodium* infection has been reported for North central plateau, Nigeria (27). This finding indicated that the children may have become infected again after treatment with the drugs. Furthermore, it is also possible that the *Plasmodium* parasites may have developed resistance to the drug. The apparent elimination half life of sulfadoxine (100 to 231 hrs) and pyrimethamine [54 to 148 hrs] (28), strongly favours re-infection than development of resistance. The possibilities of combining this drug with another effective anti-malarial drug to prolong its useful therapeutic life have been reported (29). The possible strategies for halting or reversing this trend include the temporary withdrawal of sulfadoxine-pyrimethamine drug, or combining it with other effective anti-malarial drugs, for example amodiaquine and the artemisinin derivatives (27). Community healthcare workers must take into account, cost considerations and affordability in view of the poor economic status of rural communities where the drug is mostly needed. However, it must be emphasized that the high prevalence recorded during follow-up investigation may also be an indication of re-infection rather than drug failure. This is because the life cycle of the malaria parasite is usually fourteen days.

Among those who used mosquito bed nets, the prevalence of malaria was only 5.9% compared to those that did not [21.2%] (Table 4). Among those who used screening on doors and windows in their houses, the prevalence of malaria was just 4.6% compared with those that did not [24.1%] (Table 4). These results revealed that the use of control measures reduced the prevalence of malaria and is consistent with reported cases of reduction in the prevalence of malaria due to the use of control measures against malaria (30, 31, 32).

However, in our study, the percentage of those using mosquito bed nets (2.6%) was much lower than that of those not using mosquito bed nets (97.4%). Also, the percentage of those living in houses with doors and windows screened with mosquito nets (16.9%) was lower than the percentage of those living in houses with doors and windows not screened with mosquito nets (88.1%). This low usage of malaria control measures among the school children may be due to low socio-economic status and poverty which may hamper parents from buying mosquito bed nets and screening the doors and windows of their houses with such nets. Low socio-economic status and poverty have been implicated in the high prevalence of parasitic diseases in the tropics (17). Thus, if proper and effective control measure is to be taken against malaria in the area, government should ensure the availability of mosquito nets and other malaria control materials to parents at low and subsidized rates. Parents should also be enlightened on the usefulness of control measures against malaria in the area.

In summary, this study has shown that *Plasmodiu*m infections are prevalent among school children in Igbo-Eze South LGA, Enugu State. Thus, the public health and economic implications of these findings should not be overlooked. Efforts should be made to undertake adequate control measures against the malaria parasite and its vector in Igbo-Eze South LGA. Thus, concrete steps should be taken to avert an epidemic of malaria especially among school-age children. In addition to the use of control measures such as mosquito bed nets and the screening of doors and windows of houses with nets, which the present study has shown to be effective, chemotherapeutic control of malaria in the area, and health education focussing on malaria control should be intensified both at the schools and at the community level to enhance community participation aimed at sustainable malaria control.

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