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Prevalence and pattern of malaria parasitaemia among under-five febrile children attending paediatric out-patient clinic at University of Maiduguri Teaching Hospital, Maiduguri

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Abstract*:* *Background***:** Malaria has remained a major public health problem in Nigeria with the under-five aged children and pregnant women being the most affected. The local epidemiological profile of the disease is dynamic owing to the continuous variation in the various determinants and hence the need for periodic re-evaluation. We aim to determine the prevalence of malariaparasitaemia among the under-five aged children and the effect of various determinants.

*Material and Method***:** In this cross-sectional study, 433 out-patients aged below 5 years with fever or history of fever in the previous 72hours were enrolled. Relevant information was obtained and recorded using a questionnaire. Thick and thin films were prepared from a finger or heel prick for each of the patients and subjected to microscopy.

*Result***:** The prevalence of malaria parasitaemia was 27.7%. Age, sex, nutritional status, socio-economic class, temperature at presentation as well as ownership of insecticide treated nets had no significant effect on the prevalence of malaria (p>0.05). Only *P. falciparum* was seen in all the positive slides. The parasite density was generally low with 48.3% having parasite densities below 100/µl and only 7.5% had parasite density of ≥1000/µl. Parasite density increased significantly with increasing age (p=0041). Nutritional status as well as other studied factors had no significant effect on parasite density (p>0.05).

*Conclusion and Recommendation***:** Prevalence of malaria infection was high in the population studied. It is characterized by low density parasitaemia and hence the need to interpret negative results with caution. Age, gender, socio-economic and nutritional status, temperature at presentation as well as ownership of ITN had no significant effect on prevalence of malaria parasitaemia. There is need to strengthen and scale up various malaria control programs while ensuring proper implementations of programs and activities through effective monitoring and evaluation.

Key words: Prevalence, pattern, Malaria, Parasitaemia, under-five febrile children, outpatient clinic.

Introduction

Malaria imposes great socio-economic burden on humanity, and with diarrhoea, HIV/AIDS, tuberculosis, measles, hepatitis B and pneumonia account for 85 per cent of global infectious diseases burden.[1] According to the World Malaria Report released by the World Health Organization (WHO) in 2012, there were 219 (154-289) million estimated cases of malaria in 2010 worldwide accounting for 660(610 – 971) thousand deaths. While 40%of the estimated cases occurred in India, Nigeria and DR Congo; Nigeria and DR Congo accounted for 40% of estimated death globally[2]. More than 80% of these deaths are known to occur in children younger than five years of age in Sub-Saharan Africa[3].

Several studies have been reported from the various regions of Nigeria[4-8] and beyond[9,10] (Ghana and Eretria) with varying epidemiologic profile for malaria in the under-five febrile children. However, there is dearth of information from the northeastern region. According to the Nigeria Demographic and Health survey of 2008, the

Northeastern region had the second highest prevalence of malaria among the under-five aged group[11]. This assertion however, was based on history of fever (proxy for malaria) two weeks preceding the study with no form of parasitological confirmation.It is a common knowledge that the symptom complex of malaria overlaps with those of many other tropical diseases[12] and thus may not represent the accurate epidemiologic profile of malaria. In addition, with various control measures being implemented by several agencies, the prevalence of the disease is likely to be dynamic and hence the actual epidemiologic profile may not be known after an interval of few years.

The burden of malaria in communities and countries reflect intrinsic and extrinsic determinants. Host immunity, an intrinsic factor, is age dependent in a malaria stable country like Nigeria. In such areas, the under-five age group is the most vulnerable to malaria infection[13]. Clinical malaria in them has been shown to be associated with very low parasite densities[14]. The burden of malaria is greatest among the world's poorest countries with only 0.2% of global malaria deaths found in the world's richest population quintile.[15] Nutrition plays a major role in maintaining health, and malnutrition appears to generate vulnerability to a wide variety of diseases and general ill health including malaria[16,17]. However, there are conflicting report regarding how undernutrition affects susceptibility to malarial morbidity and mortality. Several studies in malaria endemic regions of the world have documented average reduction of 20% in all causes of mortality in children under five years old within two years of increasing insecticide treated nets (ITN) use from 0 to 50-70%[18,19].

This study thus aims to determine the prevalence of malaria parasitaemia among under-five febrile children seeking treatment at the paediatric out-patient unit of the University of Maiduguri Teaching Hospital (UMTH). It also determines the associated factors and pattern of malaria parasitaemia among this age group.

Subjects and method

Study Area

The study was carried out at the paediatric general outpatient (PGOP) unit of UMTH, Maiduguri, Borno State of Nigeria. Maiduguri, the capital of Borno State is located in the northeastern part of Nigeria. It is a semi-arid zone lying between lat. 11.5^{o}N and long. 13.5^{o}E with a sunny weather and a temperature that may be as high as 45^{o}C especially in the hot dry season and an annual rainfall of 1.14 mm to 771.90 mm[20]. University of Maiduguri Teaching Hospital is a centre of excellence for infectious diseases and immunology. It serves as a referral centre not only for the six states in the region (Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe) but also for the neighboring countries of Cameroun, Chad and Niger. The Paediatric General Outpatient unit is a busy clinic with an average population of 100-150 patients per day.

Study Design

The study was a hospital based cross sectional observational study.

Study Population and sampling method

Under-five febrile children attending the Paediatric general outpatient (PGOP) unit of UMTH were eligible to participate after meeting the inclusion criteria. The physicians at the GPOP unit were educated on the inclusion and exclusion criteria and eligible patients were referred to the author after consultation for enrollment. Convenient sampling method was employed and patients were recruited consecutively after fulfilling the inclusion criteria. Calculated minimum sample size was 377 using Taylor's formula[21] and value of 'p' was taken from the study of Ikeh *et al*[7] from Jos, Nigeria who reported prevalence of 56.9%.

Inclusion Criteria

1. Age of 0-59 months
2. Fever (axillary temperature > 37.5°C), and/or history of fever in the 72 hours prior to presentation.[12]
3. Informed consent.

Exclusion Criteria

1. Children on antimalarial treatment or prophylaxis prior to presentation.

Ethical Considerations

Approval was sought from and granted by the Research and Ethical committee of UMTH. Signed or thumb-printed informed consent was obtained from each parent/guardian with unlimited liberty to deny consent or opt out of the study at any stage without any negative consequence. Information and results obtained were kept confidential. Results of the tests were disclosed to the guardians and those with positive malaria parasitaemia were given antimalarial (Artemether/lumefantrine tablets 20mg/120mg) free of charge at the expense of the researchers.

Study Procedure

The study was carried out from 5th August to 20th October 2011. On the day of inclusion, demographic and clinical information were recorded using a questionnaire. Weight was measured using a digital bathroom weighing machine (Salter Glass Electronic Bathroom Scale) in kilogram to two decimal places and for children who could not stand, the caregiver was weighed alone and then with the child and the difference of the two was taken as the child's weight. Length was measured using a tape meter on a hard cardboard surface to the nearest centimetres. Axillary temperature was measured using a digital thermometer (JOYCARE®)in centigrade to one decimal place. Socioeconomic status was determined from parental education and occupations using the model by Ogunlesi et al[22]. A score of 1-5 was awarded for each of education and occupation of both parents separately and the mean of these four scores to the nearest whole number was the socioeconomic status (I, II, II, IV and V) assigned to the child. Classes I and II belong to upper class, while Class III and classes IV and V belonged to the middle and lower socioeconomic classes, respectively. Nutritional status was assessed using the Z-score system in accordance with the National Center for Health Statistics (NCHS)/WHO reference population.[23]A weight-for-agez-score (WAZ), height-for-age z-score (HAZ) and weight-for-height z-score (WHZ) of ≥ -2 was classified as normal and Z < -2 as under-nutrition. Under nutrition was further sub classified into moderate under nutrition when WAZ, WHZ or HAZ is between -2 and -3 and as severe when < -3. Ownership of ITN was used as a proxy for usage due to the inherent difficulty in assessing actual usage in a community with no prior standardized instructions on usage and care of ITN. Thick and thin blood smears were prepared from a capillary blood sample. Number was allotted to every participant at the point of entry and was used for identification of slides and questionnaire from the same patient. The thin blood smears were fixed with methanol and the thick smears were left unfixed. Each slide was subsequently stained with 10% Giemsa solution and left for ten minutes.[24]All blood smears were examined microscopically under x100 oil immersion. The thick smears were used for diagnosis of Plasmodium specie and for parasite-density counting. Smears were considered negative if no parasites were seen in 100 oil-immersion fields. For positive smears, the number of parasites was counted against 200 white blood cells (WBC). Parasite density was calculated assuming 8,000 WBC per microlitre using the formula:

$$\text{Parasite density} = \frac{\text{Number of parasites counted}}{\text{Number of leukocytes counted}} \times 8000$$

The thin smears were examined to confirm the parasite species for positive samples. All slides were double-read, blinded, by the 6th author, a qualified and experienced microscopistfrom the Department of Parasitology UMTH and the lead author, who was retrained and certified by a parasitologist prior to commencement of the study, with an agreement of >95% between the lead author and the microscopist in slide reading. The slides with discordant findings were resolved through discussion and re-examination of such slide by the both authors at the same time with consensus reached on each case.

Data obtained were entered into a computer to generate a data base. Analysis was done using SPSS version 16.0 (SPSS, Chicago, ILL, USA). Baseline characteristics (demographic, clinical, and parasitological) were analyzed using descriptive statistics; mean, mode, medians, standard deviation, as appropriate. Results were presented in tables. Frequencies and proportions were compared using Chi-square(x^2), strength of association were tested using Contingency Coefficient. A 95% confidence interval (95% CI) and a p-value of < 0.05 was considered significant.

Results

Socio-demographic and Clinical Features

A total of 433 children were studied. There were 238 (55%) males and 195 (45%) females M:Fratio 1.2:1. The mean age of the studied population was 19.2 ± 14.3 months. Approximately half of the children studied, 203 (46.9%), were aged 12 months and below. The least frequency was observed among the 49 months and above age category, 18 (4.2%) (Table 1).

Table 1: Age and Sex distribution of the study population

Age Group (Months)	Sex: Male n (%)	Female n (%)	Total n (%)
0 - 12	118 (27.3)	85 (19.6)	203 (46.9)
13 – 24	66 (15.2)	55 (12.7)	121 (27.9)
25 – 36	25 (5.8)	31 (7.2)	56 (12.9)
37 - 48	21 (4.9)	14 (3.2)	35 (8.1)
49 - 59	8 (1.9)	10 (2.3)	18 (4.2)
Total (%)	238 (55)	195 (45)	433(100)

One hundred and sixty eight (38.8%) of the studied population had fever at presentation with axillary temperature ranging between 37.6 and 40.1°C, while 265 (61.2%) had history of fever within the preceding 72 hours. The mean, median and mode of the axillary temperature of the studied population were 37.2°C, 37°C and 38°C respectively.

Majority, 377 (77.8%), of the studied population were of low socioeconomic status. The remaining 77 (17.8%) and 19 (4.4%) of them belonged to the middle and upper socioeconomic classes respectively. This is due to the fact that majority of the parents did not go beyond secondary education (62.2% of the fathers and 81.1% of the mothers) and therefore are low income earners.

Greater than a third, 164 (37.9%), were underweight while 123 (28.4%) of them were stunted. Among the under-nourished children, moderate under-nutrition (-2 >WAZ,WHZ or HAZ ≥ -3) was more frequent than severe under-nutrition (WAZ, WHZ or HAZ < -3) accounting for 60%, 64% and 55% of under-nutrition for WAZ, WHZ and HAZ respectively.

Three hundred and seven (70.9%) of the children studied owned insecticide treated net while 126 (29.1%) did not. Sixty five (51.6%) of those who did not own ITN practiced other forms of vector control.

Prevalence and Pattern of Malaria Parasitaemia

The prevalence of malaria parasitaemia in this study was 27.7%. The effect of different variables on the prevalence of malaria parasitaemia in the study population is given in table 3. The age-group specific prevalence for malaria parasitaemia were 26.6, 27.0, 27.3, 27.8 and 44.4% for 0-12, 13-24, 25-36, 37-48, and 49-59 months, respectively. Although, slight differences were observed in the age group specific prevalence of malaria parasitaemia in this study, this difference was not statistically significant (x^2 = 2.680, p=0.611). There was slightly higher preponderance of malaria parasitaemia among males (29.8%) compared to female (25.1%), this difference was, however, not statistically significant (x^2 = 1.184, p = 0.277). The Lower SEC class recorded the highest prevalence of 41% malaria parasitaemia. The middle SEC had the least prevalence of 19.5% while the upper SEC recorded 36.8%. However, this difference was not statistically significant (X^2=1.417, p= 0.234).The prevalence of malaria parasitaemia was higher among the under-nourished children across the three measured anthropometric indices (table 2). However, these differences were not statistically significant (x^2 = 1.014, 2.597 and 0.868, for WAZ, WHZ and HAZ respectively, p>0.05).Ownership of ITN was associated with higher prevalence of 29.5% when compared to prevalence of 23.4% among those without ITN. But this difference was not statistically significant (x^2 = 1.659, p = 0.198). Febrile children at presentation had slightly higher prevalence (40.0%) of malaria parasitaemia when compared to those without fever (37.3%). However this difference was not statistically significant (x^2=0.101, and p = 0.751).

Table 2: Prevalence of malaria parasitaemia by various variables in the study population

Variables	Microscopy Positive n	Negative n	Total n	Prevalence	x^2	P-value
Age groups(Months)						
0– 12	54	149	203	26.6%	2.680	0.611
13– 24	33	88	121	27.0%		
25– 36	15	41	56	27.3%		
37– 48	10	25	35	27.8%		
49 -59	8	10	18	44.4%		
Sex						
Male	71	167	238	29.8%	1.184	0.277
Female	49	146	195	25.1%		
Socio-economic status						
Upper	7	12	19	36.8%	1.417	0.234
Middle	15	62	77	19.5%		
Lower	98	239	337	41.0%		
Nutritional status						
Weight for age: Underweight	50	50	164	30.5%	1.014	0.314
Normal	70	70	269	26.0%		
Weight for height: Wasted	49	49	151	32.5%	2.597	0.107
Normal	71	71	282	24.7%		
Height for age: Stunted	38	38	123	30.1%	0.868	0.352
Normal	82	82	310	26.5%		
Ownership of ITN						
Yes	90	215	305	29.5%	1.659	0.198
No	30	98	128	23.4%		
Temperature at presentation						
Febrile	48	120	168	40.0%	0.101	0.751
No Fever	72	193	265	37.3%		

Pattern of Parasite Density

Plasmodium falciparum was the only specie detected in all the 120 malaria positive cases. The parasite density was generally low in this study. Fifty eight (48.3%) of the positive patients had parasite densities of <100/µl of blood, while only 9 (7.5%) patients had density of 1000/µl and above. Age was the only variable significantly associated with parasite density (x^2 = 15.26, p = 0.004). Using contingency coefficient (c) a significant but weak positive correlation was found between age and parasite density (C=0.344, p=0.041). Sex, socio-economic and nutritional status, ownership of ITN and temperature at presentation had no statistically significant effect on parasite densities in this study (Table 3).

Table 3: Parasite density by various variables among the study population

Variables	Parasite density <100/µl n	100-999/µl n	≥1000/µl n	$x2$	p-value
Age groups(months)					
0-12	31	22	1	15.26	0.004*
13-36	20	25	3		
37-59	7	6	5		
Sex					
Male	31	33	7	2.286	0.319
Female	27	20	2		
Socio-economic status					
Upper & Middle	8	13	1	2.471	0.291
Lower	50	40	8		
Nutritional status					
Weight for age					
Underweight	22	25	3	1.251	0.535
Normal	36	28	6		
Weight for height					
Wasted	18	28	3	5.672	0.059
Normal	40	25	6		
Height for age					
Stunted	18	16	3	0.024	0.988
Normal	40	36	6		
Temperature at presentation					
Fever	22	23	3	0.525	0.769
No Fever	36	30	6		

*, statistically significant P < 0.05

Discussion

The prevalence of malaria parasitaemia of 27.7% in this study suggests that malaria remains a major cause of morbidity among the under-five aged group in Maiduguri and environs despite several control measures. The observed prevalence is similar to 26%reported by Ben-Edet *et al*[6] from Lagos and 27-29.5% by Ikeh *et al*[8] from Jos, Nigeria. However, other studies have found higher prevalences. While this study and the two others[6,8] with similar estimates were tertiary hospital based, the other studies with relatively higher figures were conducted in PHC facilities[7], secondary facilities[4] or community[5] based studies. This is not surprising as the lower cadre health facilities are the first point of contact, while the tertiary facilities being referral centers may be seeing patients who might have had previous treatment including antimalarials

Although age is an important determinant of malaria parasitaemia in malaria stable area, the prevalence of malaria infection in this study did not differ significantly between the age groups. This finding may not be surprising as comparison was within the under-five age group who are known to share the same immunological features regarding immunity to malaria.[13]This is similar to the findings of Akinbo *et al* in 2009 from Benin City, Nigeria.[9]Other studies comparing under-five children with older children and adults have consistently shown higher prevalence of malaria parasitaemia among the under-five group[4,5]. However, Ikeh and Teclaire[7] in 2008 reporting from Jos, Nigeria found significant difference in prevalence of malaria parasitaemia within the under-five age group. The reason for the difference in finding is not clear. On the other hand, parasite density increased significantly with increasing age. In malaria stable area like Nigeria, most children experience their first malaria infections during the first year or two of life[25]. It is known that the pyrogenic threshold of parasite density in a malaria naïve individual increases with increasing numbers of clinical episodes of malaria until premunition is attained[26]. Hence the observed relationship between age and parasite density in this study. Similarly, this study and several other studies[5,7,8,] have observed no significant effect of gender on prevalence and density of malaria parasitaemiain the under-five children.

Malaria is frequently referred to as a disease of the poor or a disease of Poverty. In this study however, socio-economic status did not have significant effect on the prevalence and density of malaria parasitaemia. It may be that there is insufficient variation in socio-economic status among the study population, since they all live within the same community (Maiduguri) to allow for significant differences to be detected. This may suggest that the overall socioeconomic status of a community may be a more important determinant than individual status similar to findings in other studies[10] . However, other studies have found low socioeconomic status to be associated with higher malaria prevalences[27]. This variation of the effect of socioeconomic status on malaria prevalence could be due to variable method of socioeconomic status classification; while Yusuf *et al*[27] used wealth index to measure socioeconomic status, this study used parental educational status in combination with parental occupation and expected income to determine the socioeconomic status of each child[22]. However, the evidence with regard to vulnerability to the consequences of malaria by groups of lower socio-economic status is more consistent[28]. This may reflect lower access to effective means of treatment once infected.

Nutrition plays a major role in maintaining health, and malnutrition appears to generate vulnerability to a wide variety of diseases and general ill health including malaria.[16,17]. In this study however, nutritional status did not have any effect on the prevalence and density of malaria parasitaemia. This finding could be due to the higher frequency of moderate under-nutrition as compared to severe form. The relationship between under-nutrition and malaria has remained controversial for many years, though most review articles suggest that under-nutrition is an important underlying risk factor for infectious diseases in general[16] and for malaria in particular.[17]More precisely, it has been shown that severe stunting induces down-regulation of the overall anti *P. falciparum* IgG antibody response.[29]

Contrary to well established positive impact of ITN on prevalence of malaria[18,19] ownership of ITN had no significant effect on the prevalence of malaria parasitaemia in this study. Similar finding has been reported by other workers[30]. This finding may be attributed to several factors; in the first place, ownership of ITN is not synonymous with usage, and even when used, lack of care for the nets may have contributed to this observation[30]. In addition, the present study did not evaluate usage of and care for ITNs. Furthermore, those who did not own ITNs were not good controls because many (51.6%) of them practiced other forms of vector control measures such as usage of insect repellent (mosquito coils) and insecticide which are known effective control measures[31].

Temperature at presentation neither had significant effect on the prevalence of malaria parasitaemia nor parasite density in this study. This finding may be due to the paroxysmal nature of malarial fever and thus history of fever may be as important as fever at presentation in the clinical diagnosis of malaria. However, while this finding is similar to the finding in other studies[32,33] with regards to prevalence of malaria parasitaemia, others[34] have found temperature at presentation to be associated with higher malaria prevalence. This study went further to demonstrate direct relationship between temperature at presentation and parasite density[34]. Hence, the observed difference could be attributed to the low parasite density recorded in this study.

Conclusion and Recommendation

Prevalence of malaria parasitaemia was high in the population studied inspite of various control measures. Malaria infection among this age group is characterized by low density parasitaemia which increases with the age and hence the need to interpret negative result with caution. Age, gender, socio-economic status, temperature at presentation and nutritional status as well as ownership of ITN had no significant effect on the prevalence of Malaria. Hence, there is need to strengthen and scale up various malaria control programs while ensuring proper implementations of programs and activities through effective monitoring and evaluation.

Limitation

The study was carried out in a tertiary health facility which is a referral centre and thus could have underestimated the burden of malaria (which is usually treated at the lower cadres of health care) in the general population.

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