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Prevalence of ocular features in children with malaria in the University of Benin teaching hospital, Benin City. A cross-sectional study.

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ABSTRACT

Background:
The study aims to assess the prevalence of ocular features in children with malaria in UBTH, Benin City.

Materials and methods:
In this hospital-based case control study at the UBTH, subjects and controls who satisfied the inclusion criteria of the study underwent ophthalmic examination for ocular features of malaria and were assessed for relevant laboratory indices necessary in the diagnosis of malaria using the revised 2014 WHO criteria.

Results:
The prevalence of ocular features of malaria was 27.5%. There was a significant statistical difference between ocular features of malaria in the cases when compared to the controls. (p=0.0001). In the anterior segment, pallor and icterus were common ocular features of malaria seen in children with malaria. There was a significant statistical difference in children who had pallor and icterus between the cases and control groups (p=0.000) and (p=0.001), respectively. One child in the control group who had oculocutaneous albinism had pendular nystagmus present. Posterior segment findings seen in children with malaria in this study included vessel abnormalities 34(19.1%), macular whitening 20(11.2%), retinal whitening 14(7.8%), retinal haemorrhage 14(7.8), disc pallor 11(6.1%), papilloedema 10(5.6%), and macular haemorrhage 6(3.4%). 102(57.3%) were males; while 76(42.7%) were females for cases, 98(55.1%) were males while 80(44.9%) were females for controls.

Conclusion:
Various patterns of ocular features are seen in children infected with malaria, with posterior segment abnormalities being more common than anterior segment changes.

Recommendations:
Better awareness should be created among medical personnel, other speciality consultants, and ophthalmologists on ocular features of malaria and its diagnostic usefulness.

Keywords: *Prevalence, Ocular features, Children with malaria, Benin City.*
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Background
The term malaria originates from Medieval Italian, when it was called "Ague" or "Marsh" fever due to its association with swamps and marshes. It was then called 'Mala aria', which means "bad air" because it was believed that bad air and marsh were the cause of the disease.[1]Malaria is a mosquito-borne infectious disease caused by a eukaryotic protozoan of the genus *Plasmodium falciparum*.[2] It is transmitted mainly by the bite of the female *Anopheles* mosquito during a blood meal. Malaria can also be acquired during blood transfusion from malaria-infected blood, while a developing fetus may get malaria from its mother.
Malaria is very common and endemic in Africa, Southern Asia, and Central and South America[3]About 3.3 billion people, which is nearly half of the world's population, are at risk of being infected with malaria.[4] It is the 3rd leading cause

of death worldwide, especially in under-fives after pneumonia and diarrheal disease.[4]One in five deaths of children under five years in Africa is due to malaria and its complications.[4] The World Health Organisation (WHO) reported that in 2015, there were 214 million registered clinical episodes of malaria and over 438,000 deaths.[4] Seventy per cent of deaths occurred in children.[4]Regardless of the fact that it is one of the oldest recorded diseases, malaria remains one of the world's most deadly infectious diseases.[5] It is arguably the greatest menace to modern society in terms of morbidity and mortality. Several centuries after its discovery, malaria remains a devastating infection to humans.[5] The study aims to assess the prevalence of ocular features in children with malaria in UBTH, Benin City.

METHODOLOGY

Study Design

This is a hospital-based case-control study.

Study Area/Location

The University of Benin Teaching Hospital is a tertiary health establishment located in Benin City, Edo State, South-south geopolitical zone of Nigeria. It provides diverse specialised healthcare for patients in Edo state and neighbouring States of Ondo, Delta, Kogi, and Bayelsa. The majority of these states are within the tropical rain forest, where malaria transmission is holoendemic and stable throughout the year, especially in under-fives. Egor Local Government Area is one of the three LGAs within the Benin metropolis and consists of ten political wards. It has its headquarters in the town of Uselu and has an area of 93 km^2 with a population of 339,899. The University of Benin Teaching Hospital is also located in this Local Government Area. Egor was chosen because it is centrally located in Benin metropolis and cuts across various socioeconomic strata, in addition to the fact that UBTH and the UBTH STAFF school are also situated in this LGA.

This study was carried out at the Children's Emergency Room, General Practice Clinic, and Paediatric wards of the University of Benin Teaching Hospital (UBTH), Benin City. The CHER is a complex with a total bed capacity of 25 and an average in-patient load of 80 per month, and a casualty room where out-patient paediatric cases are seen. The GPC has a paediatric patient load of about 20 per day and operates from 8 am to 4 pm on weekdays.

Study Duration

This study was carried out within six months, from 5th October 2017 to 13th March 2018.

Study Population

The study was conducted in children of consenting parents or caregivers, who presented with signs and symptoms of malaria according to WHO criteria, and in those patients with severe malaria who were screened and admitted by a paediatric physician into the children's emergency and paediatric wards of the University of Benin Teaching Hospital (UBTH).

Selection Criteria

Inclusion Criteria

Subjects

Children below 18 years for whom a diagnosis of malaria was made by parasite microscopy

Children below 18 years with features of malaria according to the WHO criteria.

Exclusion Criteria

Children who were on management for other known causes of coma, e.g., recent head trauma or hypoglycaemia, meningitis and encephalitis, and other causes of non-malarial fever.

Children in whom the malaria parasite was negative, whether or not they had features of malaria.

Children with a history of or on treatment for sickle cell disease.

All children whose birth was before 37 weeks of gestation or birth weight < 1.5kg because these children are at risk of Retinopathy of prematurity.

All undernourished children were excluded since severe undernutrition is associated with increased morbidity and ocular features.

Controls

Healthy age and sex matched children who attend the University of Benin Teaching Hospital Staff School and who were below the age of 18 years without a history of fever in the past 3 months were screened for *Plasmodium falciparum* malaria using the WHO standard laboratory tests and screening criteria for malaria. Those who tested negative for the parasite were included in the study for control by the following method:

After consultations with the Principal and Head Teacher of the UBTH Staff School, consent forms explaining the research procedure were distributed to the pupils and students to take home to their parents/ caregivers. One hundred and seventy-eight apparently healthy age-group and sex matched children (control) were selected from those whose parents gave informed consent. The children whose parents gave informed consent had their blood samples taken and screened for *Plasmodium falciparum* parasite by the WHO-certified microbiologist of the Department of Child Health, UBTH. Children who were positive for the malaria parasite were not included in the control group.

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Those who were negative for malaria parasite were recruited into the study from the classrooms, and their eyes were examined.

Sample Size Determination

The sample size was determined by using the Kish and Leslie 20 formula. A similar number of apparently healthy children who were age and sex matched were included as controls.

This is expressed as $n = \frac{Z^2 pq}{d^2}$

Where;
n =minimum sample size
Z = 1.96 (standard normal deviate when α is 0.05)
p = prevalence of having any ocular feature of malaria amongst children below 18 years in a 2002 study in Mali = 11.8% (Schemann *et al*[21])
therefore;
p =11.8/100= 0.118 = 0.12
q = 1-p = 1 - 0.12
d = degree of accuracy or level of precision = 5% (0.05)
Therefore,

$$n = \frac{[(1.96)^2 \times 0.12 \times (1 - 0.12)]}{(0.05)^2} = 162$$

Allowing for a 10% non- response rate,
110/100 x 162 = 178
This calculation gave a minimum sample size of 162. Allowing for a non- response rate of 10%, the minimum sample size calculated is 178. Therefore, Group A will contain 178 patients, and Group B (standard control) will contain 178 patients.
These will be age-group and sex matched.

Sampling Technique (for cases)

All children aged below 18 years with a diagnosis of malaria (uncomplicated and severe) using the WHO criteria were recruited consecutively in the study until the minimum sample size was achieved.

Sampling Technique (for control)

Sampling per classroom was done using the method of "Proportionate allocation" as shown by the formulae below:
Both nursery, primary, and secondary schools consist of classes 1-5 and JSS 1- SS3.
Primary 1 - 5 consists of classes A-C, JSS 1 –SS3 had classes A-D, respectively. Class 'A' was chosen through all the arms for the purpose of convenience.

$$\text{Number of students selected from JSS 1A} = \frac{\text{Number of students in JSS 1 'A'}}{\text{Total number of students in the school: that are in all classes 'A.' (i.e Nursery 1A, Pry 1A-5A and JSS 1A –SS3A)}} \times 178$$

UBTH STAFF school consists of nursery, primary, and secondary units and is located in Egor Local Government Area, Edo State.

Ethical Considerations

Ethical approval was sought from and granted by the Ethics and Research Committee of the University of Benin Teaching Hospital. Also, permission was sought from the Heads of Departments involved (Childhealth and Ophthalmology) and the Consultants whose patients were recruited for the study.

Informed Consent

Written informed consent was obtained from parents or primary caregivers of all participants after verbal explanation of the study. Assent was obtained from children who are of age and are able to communicate before their inclusion into the study.
Subjects and their primary caregivers were assured of the strict confidentiality of information volunteered. Assent was obtained from the children who are verbal and able to communicate.

Data Collection

The survey team consisted of
An ophthalmic senior registrar (principal investigator)
Two ophthalmic registrars
A Paediatric registrar
An ophthalmic nurse
A paediatric nurse

Questionnaire Description

A structured questionnaire was used to obtain data. It was an interviewer- administered data collection. The questionnaire was developed to consist of relevant, short, structured questions necessary to obtain relevant and useful information specifically for the study.

Questionnaire Pre-test

The questionnaire was pre-tested among patients diagnosed with malaria in the Children's Emergency and Paediatric wards in Central Hospital, Benin City, which is a centre that has similar patient demographics to the University of Benin Teaching Hospital (UBTH) and is located about 10 km away from UBTH. A correction was made before the final questionnaire for the study was printed out. These patients were not included in the final analysis.

Research Materials

Questionnaire (interviewer-administered)
Snellen visual acuity chart, Kay-picture charts (literate and illiterate)
Pen torch

Meter rule
Keeler Pulsair non-contact tonometer – intellipuff
Keeler direct ophthalmoscope
Zeiss Portable Slitlamp Microscope
Mydriatic eye drops – Tropicamide (1%) and phenylephrine (2.5%)
Binocular indirect ophthalmoscope (BIO) (Appasamy) – model AAIO
+ 20D non contact lens (Volks)
iPhone 6 (Apple) model A1586
Eye swabs
Weighing scale with extendable meter rule – health scale RG2- 12
Mechanical bench Scale (SALTER model 180 England)
Mechanical floor Scale (SECA model 761)

Data Collection Procedure

Data collection procedure was done at the Children's Emergency Ward, GPC, and Paediatric ward of the University of Benin Teaching Hospital. Questionnaires designed specifically for the study were administered by the study, assisted by the ophthalmic registrars. General examination was done, and vital signs of subjects were taken by the Nurses. Ocular examination was carried out for both subjects and controls by the author, as the lead researcher, assisted by the ophthalmic resident doctors. The findings were recorded in relevant sections of the form. The presenting visual acuity (PVA) was assessed by the principal researcher uniocularly and then binocularly in patients who are conscious and oriented, unaided first, then with the subject's present spectacles or visual aids, where his or her unaided VA was less than 6/9. Fixation and following light and behavioural pattern to occlusion of the good eye was employed for preverbal children, picture charts for verbal children, and Snellen's visual acuity charts and E charts were employed for older children as appropriate. Under normal daylight supplemented with fluorescent electric light, the chart was placed at a distance of 6m, and the subject was asked if he/she could see and read. When a subject was unable to see the largest print (6/60), the chart was moved 1m closer to the subject until he/she was able to see the largest optotype. This was recorded as 6/60, 5/60, 4/60, 3/60, 2/60, or 1/60. When a subject was unable to see/ read the largest optotype or count fingers at a distance of 1m, hand movement (HM) was tested by waving the hand in front of the eye. This was recorded as HM when identified. When not attainable, perception of light (PL) was tested by shining a pen torch into the eye. This was recorded as PL when correctly visualised, but if not, the visual acuity was recorded as nil perception of light (NPL). Examination of the ocular adnexa and anterior segment was done using a pen torch, a magnifying (binocular) loop (x2.5), and a Zeiss portable handheld slit lamp microscope. Intraocular pressure measurement was done with a Keelers pulsair non- contact tonometer.

Children who were 18 years and below and diagnosed with malaria (Study participants) had dilated fundus examination by direct and indirect ophthalmoscopy and were assessed by the study for ocular and retinal signs of malaria. Fundus examination was carried out using the wireless binocular indirect ophthalmoscope after pupillary dilatation (with commercially available 1% tropicamide and 2.5% phenylephrine eye drops). This was carried out by the study, and findings were recorded in relevant sections of the form. Laboratory investigations were requested by the Paediatric physician and registrar for children presenting with symptoms suggestive of malaria.

Laboratory microscopy

Microscopic detection and identification of Plasmodium parasites was done by the microbiologist using Giemsa-stained thick and thin blood films**.** Haemoglobin was measured using the 18-parameter automatic haematology analyser (System KX -21, Japan). Screening for sickling was done by the haematologist using the sodium metabisulfite method in patients who presented with features suggestive of sickle cell disease. Cerebrospinal fluid examination was done by the paediatrician via lumbar puncture to rule out meningitis. These results were retrieved from the case files of patients who have had these investigations done and documented already.

Confirmation of malaria in study participants.

Diagnosis of malaria parasite

Diagnosis of malaria was done by the demonstration of malaria parasites on microscopy.

Procedure for microscopy

Blood film was prepared for all the study participants from blood obtained from a peripheral vein of each child. Blood samples were stored in an ethylene diamine tetraacetate (EDTA) anti-coagulant bottle before being taken to the laboratory for analysis.

Limb veins (preferably the hand for comfort) were used for sample collection. The sample was collected after skin preparation on the anatomical site with a wet swab (cotton wool with methylated spirit). Each specimen bottle was labelled with the child's identification number as recorded on the questionnaire administered at recruitment, and then sent to the Department of Child Health, UBTH Research Laboratory for preparation of thick and thin films. The thick and thin films were used for determining malaria parasite density (parasite count) and species identification, respectively. Samples were collected at presentation and sent to the laboratory immediately. Analyses were done within 2 hours of presentation in the hospital.

Technique for blood film for malaria parasite

Thick smear

One or two drops of blood from a blood pipette were placed at the centre of the pre-cleaned, labelled slide.

Using the corner of another slide or an applicator stick, the drop of blood was spread in a circular pattern or the size of a coin (1.5cm ^{2}).
The slide was then laid flat and allowed to dry.
After a minimum of 30 minutes, the slide was stained with Giemsa stain and viewed under the microscope at X100 magnification.

Thin smear

A drop of blood was placed on a pre-cleaned, labelled slide, near the frosted end.
A smear of the blood sample was made on the slide.
The smear on the slide was allowed to air- dry for about 10 minutes by placing the slide in a horizontal position.
The smear was then fixed by dipping the slide in absolute methanol solution and allowing it to dry in air for 1-2 minutes.
The slide was then stained at pH 7.1 – 7.2 using Giemsa stain and was viewed under the microscope for malaria parasite species.
The malaria parasite identification was done by the WHO-certified Chief laboratory scientist who currently works at the Paediatric microbiology laboratory of the Department of Child Health, UBTH.
A high-power (100X objective) microscope field for each slide was examined, and the malaria parasite was recorded as positive or negative. Parasite count for each patient was obtained using the formula proposed by Greenwood and Armstrong. This was done by multiplying the average number of parasite trophozoites counted per high-power field (100X objective) by 500. This method has been observed to be more accurate and quicker in determining parasite count and has been recommended by the WHO in malaria-endemic regions.
As per institutional practice at this time of the study, patients with severe malaria were managed using the current University of Benin Teaching Hospital treatment protocol (WHO Standard Treatment Protocol):
Children with severe anaemia were transfused with whole blood or fresh frozen plasma. Those who had severe anaemia and respiratory distress were placed on humidified oxygen by facemask or nasal prongs. Hypoglycemia was corrected with an intravenous 10% dextrose solution. This treatment was administered by the Paediatrician in the Department of Child Health, UBTH.

Data Management

Data collected was cross-checked for completeness. Any incomplete data was discarded. Analysis of data collected was done using a computer and the Statistical Package for the Social Sciences (SPSS) version 21 software. The children's ages were stratified into less than 5 years, 5 to 9 years, and 10 years and above (below 18 years). Quantitative variables in the study were summarised using means and standard deviations or medians and ranges, where applicable. Frequency tables and charts were constructed as appropriate, such as the demographic characteristics and ocular features identified in the subjects and control groups. The relationship between ocular features and the identified factors was presented as bivariate frequency tables and charts where applicable. The association between ocular features seen and the common clinical syndromes of malaria infection was analysed using the chi-square test, where applicable. The level of significance of each test was set at $p < 0.05$ and 95% confidence level.

RESULTS

A total of one hundred and seventy-eight (178) children with malaria met the inclusion criteria for the study; for the control group, a hundred and ninety-two (192) children who attend the UBTH STAFF school, whose parents gave informed consent, were also registered for the study, from which 178 were selected to meet the sample size. A total of 33 ethnic tribes/ languages were represented among the subjects for both cases and controls. However, the majority were from the Bini ethnic group, which had the highest frequency of 72 subjects (40.4%) for cases and 91 subjects (51.1%) for controls. This was followed by the Igbo ethnic group, who had 32 subjects (18%) and 17(9.6%) for cases and control, respectively, and the Etsako 12(6.7%) and 7(3.9%) ethnic group for cases and control, respectively. The majority of the subjects (159) with malaria (cases) resided in Edo state, while 19 had come in from the surrounding states of Ondo, Delta, Kogi, and Bayelsa. All the subjects that were used for control resided in Benin City, Edo State.

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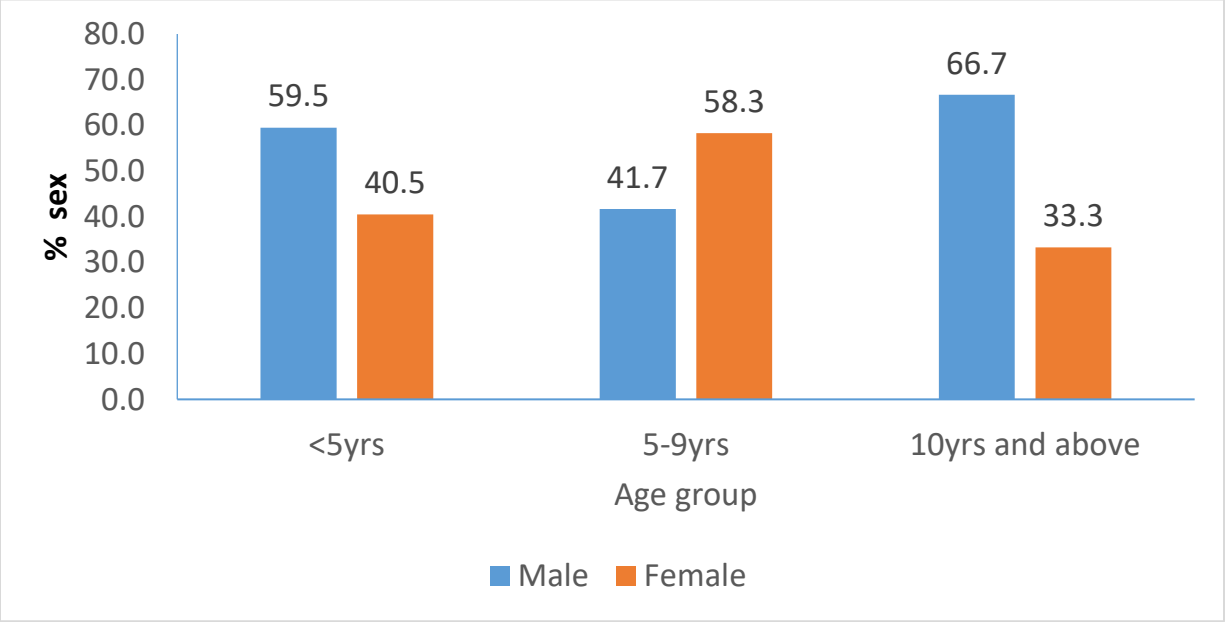
Table 1: Socio-demographic characteristics of cases and controls

Variable	Cases(%) N=178 n=178	Controls(%) N=178	χ^2	P
Sex				
Male	102(57.3)	98(55.1)	0.183	0.669
Female	76(42.7)	80(44.9)		
Age group				
<5yrs	112(62.9)	117(62.6)	0.163	0.922
5-9yrs	48(27.0)	53(28.3)		
10yrs and above	18(10.1)	17(9.1)		
Mean age (yrs)	4.08±3.85	4.04±2.49	0.116	0.907

Analysis of the 178 children recruited for this study shows that 102(57.3%) were males, while 76(42.7%) were females. For cases, 98(55.1%) were males, while 80(44.9%) were females for controls. (Table 1). Giving a male-to-female ratio of 1.34:1 for cases and 1.225:1 for controls. The ages of the subjects ranged from 11months to 16 years for cases and 3 years to 17 years for controls. The mean age for the cases and control were4.08±3.85and 4.04±2.49respectively, while the modal age for both groups was 4years.The median (IQR) age of the children in this study is 2.0(1.0 – 6.0) yrs. The children's ages were divided into 3 groups: <5yrs, 5-9yrs, and >10yrs. The majority of the children are in the < 5-year age group. There was no significant statistical difference between the sex and age of the cases and control groups ($p > 0.05$).

Figure 1: Age and sex distribution of the children with malaria in UBTH.



$\chi^2 = 1.484$; $p = 0.476$

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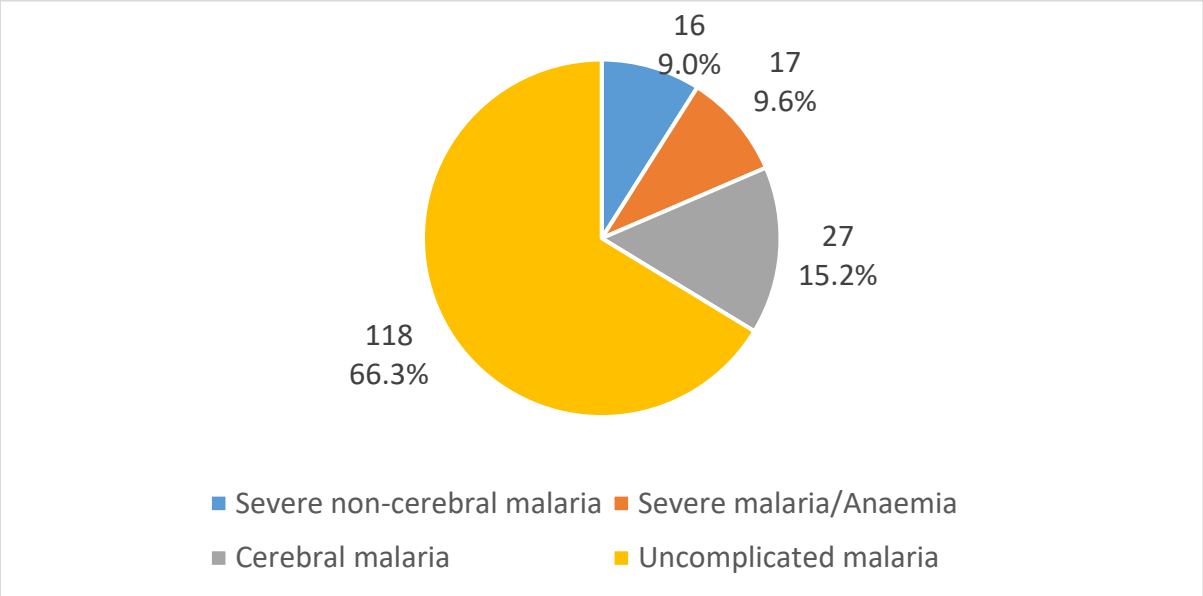
The subjects recruited into the study were grouped into three age groups, viz. <5,5-9 and 10 years and above. There is no significant difference (p=0.476) in the gender distribution in each age group.

Figure 2: Distribution of malaria in children in UBTH.



One hundred and eighteen (66.29%) children had the mild (uncomplicated) form of malaria, and 60(33.7%) had the severe (complicated) form of malaria. 16(9.0%) children had severe non cerebral malaria, 17(9.6%) had severe malaria anaemia and 27(15.2%) had cerebral malaria.

Table 2: Malaria parasite density in children in UBTH.

	Frequency	Percentage
+*	118	66.3
++**	34	18.5
+++***	26	15.2
Total	178	100.0

*1-10 *Plasmodium falciparum* parasites per 100 HPF
**10-100 *Plasmodium falciparum* parasites per 100 HPF
***1-10 *Plasmodium falciparum* parasites per HPF
The majority of children had low malaria parasite density (Table 2)

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To determine the prevalence of ocular features in children with malaria in UBTH, Benin City.

Table 3: Prevalence of ocular features of malaria in cases and controls in UBTH

Ocular feature	Cases n(%)	Control n(%)	χ^2	P
Anterior segment				
Pallor	21.0(12.0)	0.0(0.0)	22.316	0.000
Icterus	10.0(5.6)	0.0(0.0)	10.289	0.001
Blepharitis	6.0(0.0)	4.0(0.0)	2.046	0.153
Keratitis	0.0(0.0)	0.0(0.0)	-	-
Uveitis	0.0(0.0)	0.0(0.0)	-	-
Hyphaema	0.0(0.0)	0.0(0.0)	-	-
Squint	3.0(0.0)	4.0(0.0)	4.045	0.141
Subconjunctival haemorrhage	0.0(0.0)	0.0(0.0)	-	-
Nystagmus	0.0(0.0)	1.0(0.0)	0.317	1.00
Posterior segment				
Vessel abnormalities	34(19.1)	0.0(0.0)	37.590	0.000
Macular whitening	20(11.2)	0.0(0.0)	21.120	0.000
Retinal haemorrhage	14(7.8)	0.0(0.0)	14.575	0.000
Retinal whitening	14(7.8)	0.0(0.0)	14.573	0.000
Disc pallor	11(6.1)	0.0(0.0)	10.289	0.001
Papilloedema	10(5.6)	0.0(0.0)	11.351	0.001
Macular haemorrhage	6(3.4)	0.0(0.0)	6.103	0.013
Any ocular feature*	47(27.5%)	9(5.1%)	30.599	0.0001

**One or more of any ocular feature*

The prevalence of ocular features of malaria was 27.5%. There was a significant statistical difference between ocular features of malaria in the cases when compared to the controls. (p=0.0001). In the anterior segment, pallor and icterus were common ocular features of malaria seen in children with malaria. There was a significant statistical difference in children who had pallor and icterus between the cases and control groups (p=0.000) and (p=0.001), respectively. Blepharitis and squint were anterior segment findings also seen in cases; these were also present in the control group. There was no significant statistical difference in children who had blepharitis or squint between the cases and the control group (p=0.153) and (p=0.141), respectively. One child in the control group who had oculocutaneous albinism had pendular nystagmus present. No child with malaria (cases) had nystagmus present in the anterior segment. Posterior segment findings seen in children with malaria in this study included vessel

abnormalities 34(19.1%), macular whitening 20(11.2%), retinal whitening 14(7.8%), retinal haemorrhage 14(7.8), disc pallor 11(6.1%), papilloedema 10(5.6%), and macular haemorrhage 6(3.4%). There was a significant statistical difference between cases and controls for all posterior segment findings of ocular features of malaria. ($p< 0.05$).

DISCUSSION

The prevalence of ocular features of malaria in this study was 27.5%. Vessel abnormalities had the highest prevalence (19.1%) of ocular features seen in children with *Plasmodium falciparum* malaria in UBTH. This was followed by perimacular whitening (11.2%) and retinal haemorrhages (7.8%). Other posterior segment ocular features seen in this study included retinal whitening (7.8%), which resulted from retinal ischaemia, papilledema (5.6%), disc pallor (6.1%), and macular haemorrhage(3.4%).

No conjunctival, epibulbar, or episcleral haemorrhages, hyphaema, uveitis, keratitis, ophthalmoplegia, and other anterior segment ocular features of malaria were reported in this study. Conjunctival pallor and icterus due to jaundice as a result of the systemic effect of malaria, where the anterior segment ocular features of malaria were seen. Blepharitis and squint were also anterior segment findings encountered in this study, but were present in both cases and the control. There was no statistical difference in children who had blepharitis and squint between cases and controls. This may be explained by the fact that blepharitis, which was encountered in the study, may have been due to other known common causes, such as generalised seborrhoeic dermatitis and bacterial infection by Staphylococcus aureus. Squint, which was also encountered in this study, could also have resulted from poor vision due to refractive errors in the study subjects and controls. One female pupil in the control group who had a squint in the left eye during dilated fundoscopy and bilateral indirect ophthalmoscopy was found to have a presumed old toxoplasmosis scar on the macula. A child among the children recruited for controls who had oculocutaneous albinism had jerk nystagmus. Nystagmus is a known ocular feature of albinism in children and adults. Although Chuka and Ike[6] in their review of literature had drawn our attention to other anterior segment features of malaria, which were earlier reported in previous studies to include epibulbar and subconjunctival haemorrhages, uveitis, and ophthalmoplegia, these were not seen in children with malaria in this study. This was similar to previous studies in Ghana, Mali, Malawi, Nigeria, and Zambia, where no anterior segment feature that may have resulted directly from malaria was reported.[7,9,10,11,13] This study was also in contrast to the study by Biswas et al[8,] who documented anterior segment findings of malaria in their study, including anterior uveitis, secondary glaucoma, subconjunctival and episcleral haemorrhage. Hidayat et al[12] also documented anterior segment findings to include conjunctival and episcleral haemorrhages. The findings in this study did not agree with the findings in the study in India, where anterior segment ocular features of malaria were reported to include keratitis and uveitis.

Conclusion

Various patterns of ocular features are seen in children infected with malaria, with posterior segment abnormalities being more common than anterior segment changes. The ocular features of malaria are more frequently found in patients with more severe malaria infestation.

Limitations

Measurement of the presenting visual acuity of the majority of the subjects was a major challenge because those who had the severe form of malaria were critically ill and drifting in and out of consciousness, while others were comatose. Those who had the uncomplicated form of malaria and were conscious were quite ill, irritable, and therefore uncooperative to instruction by the study.

Recommendations

Better awareness should be created among medical personnel, other speciality consultants, and ophthalmologists on ocular features of malaria and its diagnostic usefulness.

Acknowledgement

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List of abbreviations
UBTH: University of Benin teaching hospital.
WHO: World Health Organisation

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Data availability
Data is available upon request.

Author contribution
Johnpaul Oshorenua Okolo collected data and drafted the manuscript of the study.
Prof. A.E. Omoti supervised the study
Dr . O.M. Uhumwangho supervised the study
Dr. D.U Nwaneri supervised the study

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