



## HAEMATOLOGICAL PROFILE OF NIGERIAN ADOLESCENTS BEFORE AND AFTER TREATMENT OF *PLASMODIUM FALCIPARUM* INFECTION

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### ABSTRACT

Nigeria has a very high prevalence of malaria, especially among children and adolescents. The aim of this study was to evaluate the haematological profile of adolescents before and after treatment of *Plasmodium falciparum* infection. It was an observational longitudinal study of 91 adolescents which comprises of 61 (67.0%) subjects with mild to moderate infection and 30 (33.0%) apparently healthy controls. The study was carried out in Nigeria National Petroleum Corporation Medical services Akpajo, Port Harcourt, Rivers state. Three milliliters of whole blood stored in EDTA bottle was used for the assays. Abacus 380 Haematological Analyzer was used for the analysis of full blood count; while malaria parasite diagnosis was done using RDT, quantitative buffy coat for malaria parasite and thick blood film. Infected subject were treated with antimalaria drug. Graph Pad Prism was used for data analysis and T-test was used to test for association. P-value of < 0.05 was considered significant at 95% confidence interval (CI). There were 49 males and 42 females with mean age of 13.72 years. At baseline (before treatment), there was significantly lower haemoglobin (p=0.0001), haematocrit (p=0.002), red cell distribution width (RDW) (p=0.033) and platelet distribution width (PDW) (p=0.034) among the infected subjects when compared to control group. Males had higher total white blood cell count (TWBC) (p=0.001), haemoglobin concentration (p=0.016), haematocrit (p=0.001), RDW (p=0.031) and PDW (p=0.020) when compared to females. After treatment of the infection, there was significantly decreased TWBC (p=0.0001), lymphocytes (p=0.005) and haematocrit (p=0.017); with increased mean cell volume (MCV) (p=0.0001), mean cell haemoglobin (MCH) (p=0.0001) and PDW (p=0.007). Also, males had significantly higher TWBC (p=0.0002), mid cell (p=0.0001) and PDW (p=0.049); with lower granulocytes (p=0.040), MCV (p=0.001), MCH (p=0.001), mean cell haemoglobin concentration (MCHC) (p=0.026) when compared to females after treatment. Malaria affects haematological indices of adolescents. There is need for health promotion and education campaigns to enlightening the masses on the strategies for prevention and management of malaria infection.

**KEYWORDS:** Malaria, Haematological Indices, Adolescents, Nigeria.

### INTRODUCTION

*Plasmodium falciparum* malaria is the major cause of death in Africa, affecting mostly children, adolescents and women in poor communities.<sup>[1][2]</sup> Malaria causes significant burden on population economy.<sup>[3]</sup> Malaria is caused by a protozoa parasite, the different species that affect humans are *P. falciparum*, *P. ovale*, *P. vivax*, *P. malariae* and *P. knowlesi*. It is transmitted through the bite of female Anopheles mosquito. Humans become infected when mosquito takes a blood meal, resulting in the release of sporozoites which undergo further replication.<sup>[2]</sup>

Manifestation of the disease condition in humans vary, ranging from uncomplicated mild malaria (MM) to severe non cerebral malaria (SM), to cerebral malaria; with various clinical symptoms such as metabolic

acidosis, seizure, repeated convulsion and coma stage II, leading to death.<sup>[4]</sup> The most severe form of malaria is caused by *P. falciparum* and the clinical features include fever, chills, headache, muscular ache, weakness, vomiting, and abdominal pain. Other symptoms are anaemia, organ failure, pulmonary oedema, convulsion that could lead to coma and death.<sup>[5]</sup> *Plasmodium falciparum* causes abnormalities such as severe malaria, anaemia and cerebral malaria found in non-immune individual, children and pregnant women having high mortality and morbidity rate.<sup>[6]</sup> In the host immune system, malaria symptoms produce complex interaction between *Plasmodium* and immune cells.<sup>[7]</sup>

The high prevalence of malaria infection in Nigeria, with its undesirable effects on the health of the victims and

the economy of the nation were the basis for this research.

## MATERIALS AND METHODS

### Study Design

This was an observational longitudinal study.

### Study Area

The study was carried out at Nigerian National Petroleum Corporation (NNPC) Staff Clinic Akpajo, Port Harcourt, Rivers State; with geographical coordinate of 4.819° N, 7.0900° E. Port Harcourt is the capital of Rivers State, situated in southern part of Nigeria. It lies along the Bonny River. Port Harcourt is an important economic center in Nigeria especially the petroleum sector.<sup>[8]</sup>

### Study Population

The study is limited to adolescent males and females aged 11-17 years, infected with *Plasmodium falciparum* malaria in Port Harcourt as study group. The control subjects were apparently healthy adolescents who had not suffered from malaria infection in the past one month.

### Inclusion and Exclusion Criteria

Males and females of age 11-17 years who tested positive for *Plasmodium falciparum* served as the study group, while those who tested negative were used as control. Also, those who were over the age of 17 years and those suffering from other disease conditions were excluded from the study.

### Sample Size Calculation

G-power version 2.0.10 was used to calculate the sample size; with parameters such as error of probability at 0.05, power (1-β error) at 0.95 (95%), and effect size of 0.5. This yielded sample size of sixty-one (61) adolescent infected with *Plasmodium falciparum* and thirty (30) apparently healthy non-infected adolescents, giving a total of ninety-one (91) subjects.

### Ethical Consideration

Ethical clearance was obtained from the Department of Medical Laboratory Science, and permission granted by NNPC Hospital Research Department Port Harcourt, prior to management approval. Verbal consent was obtained from the guardians or parents of the participants.

### Laboratory Analysis

#### Sample Collection

Three milliliters of blood was collected from test and control subjects and dispensed into ethylenediaminetetraacetic acid (EDTA) anticoagulant for the analysis of full blood count (FBC) and malaria parasite.

### Methods of Analysis

#### Determination of *Plasmodium falciparum* Infection

Three methods of malaria parasite identification was used:

1. Rapid diagnostic test (RDT)
2. Quantitative Buffy Coat (QBC)
3. Microscopy (Thick blood film)

#### *Rapid Diagnostic Test (RDT) using Standard Diagnostic Kit*

**Principle:** This is based on immune-chromatography quantitative detection of histidine rich protein 11 (HRP 11) antigen in human whole blood for *Plasmodium falciparum* malaria which entails capturing of dye labeled antibodies to produce visible colored line on strip of nitro-cellulose in plastic called cassette. The labeled antibody binds to the malaria parasite specific antigen (protein) to form a visible band called T test line in the result window, a second line is also formed (the control line) which gives the capability of the antibody dye to conjugate. Rapid diagnostic test was performed according to manufacturer specification and instruction, parasite density was calculated using the assumed number of white blood cell of 8000/ul of blood.<sup>[9][10]</sup>

**Procedure:** Commercially available (SD) malaria P.F HRP-11 Antigen rapid test from Standard Diagnostic Inc. Lot No 05CDB018B, expiry date 2018 /02 was used according to manufacturer directions and specifications.

Test and control blood samples were mixed with lysing agent in a test strip or well. This caused the rupture of red blood cells, releasing more parasite protein. Dye-labeled antibody specific for target antigen, present on the lower end of nitrocellulose strip or in a plastic well was provided with the strip. Another antibody specific for the target antigen is bound to the strip in a thin (test) line, and either antibody specific for the labeled antibody or antigen is bound at the control line.

Blood and buffer, which have been placed on strip or in the well, were mixed with labeled antibody, drawn up by the strip across the lines of bound antibody labeled antibody react with antigen present in the blood to form-antigen antibody complex which has been trapped and accumulate on the test line. Excess-labeled antibody trapped accumulates on the control line. Visible control line indicated that labeled antibody has traversed the full length of the strip, past the test line, and that at least some free antibody remained conjugated to the dye and some of the capturing properties of the antibodies remain intact.

The intensity of the test band varied with the amount of antigen present, at least at low parasite densities (antigen concentration), as this was determined by the amount of dye particles which accumulated on the line. The control band intensity may decrease at higher parasite densities, as much of the labeled antibody will have been captured by the test band before reaching the control.

#### Quantitative Buffy Coat (QBC)

**Principle:** QBC malaria tubes contains a fluorochrome known as acridine orange capable of binding with

deoxyribonucleic acid and ribonucleic acid, nuclei of the parasites emit yellowish green fluorescence whereas the cytoplasm exhibits bright red fluorescence. RBCs are not stained by the dye, hence remain inconspicuous under fluorescent light (dark background) while the brightly fluorescent parasites are easily seen by fluorescent microscopy

**Procedure:** Fifty-five (55) microliters of blood was drawn by capillary action into QBC malaria tube pre coated internally with acridine orange. The tubes were rotated for ten seconds to allow the content dissolve appropriately. One end of the tube was seal with cylindrical tight-fitting Plastic float of 1.055 specific gravity, was inserted into the tubes, centrifuged at 12,000g for 5minutes, blood component and parasite were separated based on density and concentration in distinct layer.

The tube was viewed under a fluorescent microscope. Malaria parasites were seen concentrated, shining in the background of dark red blood cells. According to manufacturer QBC malaria test is 5.5 to 7% sensitive, it can detect one parasite per microliter of blood.

Positive samples with RDT and QBC were confirmed with a gold standard method, thick blood film.

#### **Thick Blood Film (Microscopy)**

This is the gold standard for malaria parasite.

**Principle:** Blood films were stained using Giemsa Stain, the nucleus and cytoplasm of white blood cells takes up characteristic blue or pink coloration.

**Procedure:** 50µl of blood was dropped on a grease free slide, smeared and allowed to dry. It was then stained with 10% Geimsa and examined under the microscope with ×100 (oil immersion) objective.<sup>[11]</sup>

#### **Determination of Full Blood Count (Abacus 380 Autoanalyser)**

**Principle (Electrical impedance method):** Whole blood passes through two electrodes in a narrow aperture, the cells are suspended in an electrically conductive diluent as each cell passes through the aperture, continuous direct current flow between the external and internal electrodes, these causes some changes in the impedance to cell volume that result in cell counting and measurement of volume. These changes were recorded as increase in voltage occur between the two electrodes, distribution of the cell is displayed on diagram which includes the following three parts differentials WBC,RBC, and PLT histogram.

**Procedure:** Sampling process was initiated by pressing the start button on the touch screen, test and control subject data was key into the screen. The analyzer aspirated 25µl of anticoagulated blood (k3-EDTA) into the sampling needle, Sample was mixed with 4mls of

diluents (diatro-dill-differential which is then store in the chamber (mixed dilution).

Mixed dilution of 20µl was aspirated into the needle for white blood cell and haemoglobin analysis. Lysing reagent (diatron-lyse differential was added to mixed dilution held on the chamber of white blood cell differential. The analyzer performs the white blood cell count, read the haemoglobin followed by washing process, 4mls of diluents was then added to the second dilution being the balance of 25µl of mixed dilution that has been store in the needle.

The above portion was used for red blood cell count, platelet count and other parameters. Another washing process occurred which prepare the analyzer for the next analysis. All result was displayed on the screen.

#### **Statistical Analysis**

The statistical analysis was performed using the Graph Pad Prism and Microsoft excel. Results obtained were presented as graphs and tables. Normality of data was checked with Kolmogorov-Smirnov test. Data description was presented as mean ± standard deviation (SD). T-test was used to test for association. P-value of ≤0.05 was considered significant at 95% confidence interval (CI).

## **RESULTS**

### **Demographic Details of Study Population**

There were 49 males and forty-two (42) females in this study within the age range of 13-17 years, with mean age of 13.72 (Table 1).

**Table 1 Demographics Details of the Study Population**

Items	Status
Total No. of subjects	91
No. of test group	61
No. of Control	30
Males	49
Females	42
Age of subjects (Years)	
Range	13 – 17
Mean	13.72

### **Comparison of Mean ± SD of Age and White Blood Cell Indices of Study Population at Baseline.**

The comparison of mean± SD of age and white blood cells of study population at baseline shows that there was no statistically significant difference between the mean age and white blood cell indices of the test group compared to the control group (Table 2).

**Table 2: Comparison of Mean  $\pm$  SD of Age and White Blood Cell Indices of Study Population at Baseline.**

	AGE (Years)	WBC ( $10^9/L$ )	LYM (%)	MID (%)	GRA (%)
Control (n=30)	13.9 $\pm$ 1.95	5.61 $\pm$ 3.65	50.48 $\pm$ 10.39	12.88 $\pm$ 4.4	34.69 $\pm$ 9.27
Test (n= 61)	13.79 $\pm$ 1.62	5.19 $\pm$ 1.45	49.84 $\pm$ 9.4	14.22 $\pm$ 6.4	35.94 $\pm$ 6.94
p-value	0.785	0.546	0.775	0.244	0.516

**Key:** WBC - White blood cell, LYM –Lymphocyte, MID - Mid cell, GRA – Granulocyte.

#### Comparison of Mean $\pm$ SD of Red Cell and Platelets Indices of the Participants at Baseline

Comparison of red blood cell and platelet indices showed that there was statistically significant decrease in the mean value of haemoglobin, haematocrit, red cell

distribution width and platelet distribution width in test group when compared to the control group at baseline (P=0.0001, P=0.002, P=0.033 and P=0.034, respectively). While there was no statistically significant difference in the mean value of mean cell volume, mean cell haemoglobin, mean cell haemoglobin concentration and platelets in test group compared to control at baseline (Table 3).

**Table 3 Comparison of Mean  $\pm$  SD of Red Cell and Platelets Indices of Study Population at Baseline and Control.**

	HGB(g/dL)	HCT (%)	MCV(fl)	MCH (pg)	MCHC(g/dL)	RDW (%)	PLT( $10^9/L$ )	PDW (%)
Control (n=30)	12.43 $\pm$ 1.24	39.11 $\pm$ 3.35	80.63 $\pm$ 5.86	25.27 $\pm$ 1.97	31.44 $\pm$ 0.67	15.82 $\pm$ 0.93	234.1 $\pm$ 101	40.18 $\pm$ 1.63
Test (n= 61)	11.15 $\pm$ 1.29	36.19 $\pm$ 5.18	80.03 $\pm$ 5.3	25.09 $\pm$ 1.76	31.31 $\pm$ 0.60	15.44 $\pm$ 0.86	244.7 $\pm$ 62.17	39.4 $\pm$ 1.57
p-value	0.0001*	0.002*	0.637	0.667	0.365	0.033*	0.601	0.034*

**Key:** HGB – haemoglobin, HCT – haematocrit, MCV – mean cell volume, MCH – Mean cell haemoglobin, MCHC – mean cell haemoglobin concentration, RDW – red cell distribution width, PLT – platelets, PDW – platelets distribution width, \* - Significant

When the mean age and white blood cells indices of males and females were compared at baseline, there was statistically significant increase in the mean value of white blood cell in males when compared to females (P=0.001). Whereas the mean of other parameters had no significant variation for both genders (Table 4).

#### Comparison of Mean $\pm$ SD of Age and White Blood Cell Indices of Males and Females at Baseline

**Table 4: Comparison of Mean  $\pm$  SD of Age and White Blood Cell Indices of Males and Females at Baseline.**

	AGE (Years)	WBC ( $10^9/L$ )	LYM (%)	MID (%)	GRA (%)
Females (n= 27)	14.04 $\pm$ 1.67	4.56 $\pm$ 1.07	51.48 $\pm$ 6.02	13.19 $\pm$ 5.13	35.34 $\pm$ 5.69
Males (n=34)	13.59 $\pm$ 1.58	5.69 $\pm$ 1.53	48.54 $\pm$ 11.33	15.04 $\pm$ 7.17	36.42 $\pm$ 7.85
p-value	0.291	0.001*	0.199	0.246	0.536

**Key:** WBC - White blood cell, LYM – Lymphocyte, MID - Mid cell, GRA – Granulocyte, \* - Significant

#### Comparison of Mean $\pm$ SD Red Cell and Platelet Indices of Males and Females at Baseline

Comparison of the mean red cell and platelet indices of males and females at baseline revealed that there was

statistically significant increase in the mean value of haemoglobin, haematocrit, red cell distribution width and platelet in males when compared to the females (p=0.016, p=0.001, p=0.031 and p=0.020, respectively); while others parameters showed no significant variation in mean for both genders (Table 5).

**Table 5: Comparison of Mean  $\pm$ SD Red Cell and Platelet Indices of Males and Females at Baseline.**

	HGB(g/dL)	HCT(%)	MCV(fl)	MCH (pg)	MCHC(g/dL)	RDW(%)	PLT( $10^9/L$ )	PDW(%)
Females(n= 27)	10.71 $\pm$ 1.18	33.94 $\pm$ 3.38	80.81 $\pm$ 5.19	25.35 $\pm$ 1.75	31.37 $\pm$ 0.48	15.19 $\pm$ 0.51	224.4 $\pm$ 56.41	39.42 $\pm$ 1.31
Males(n=34)	11.5 $\pm$ 1.27	37.97 $\pm$ 5.69	79.41 $\pm$ 5.29	24.88 $\pm$ 1.76	31.26 $\pm$ 0.68	15.64 $\pm$ 1.02	260.9 $\pm$ 62.56	39.38 $\pm$ 1.77
p-value	0.016*	0.001*	0.303	0.305	0.484	0.031*	0.020*	0.921

**Key:** HGB – haemoglobin, HCT – haematocrit, MCV – mean cell volume, MCH – Mean cell haemoglobin, MCHC – mean cell haemoglobin concentration, RDW – red cell distribution width, PLT – platelets, PDW – platelets distribution width, \* - Significant.

#### Comparison of Mean $\pm$ SD of Age and White Cell Indices of Subjects with Malaria after Treatment

Comparison of white blood cell indices of malaria infected subjects before and after treatment revealed a statistically significant decrease in the mean values of white blood cell and lymphocytes after treatment (P=0.0001 and P=0.005, respectively), while others parameters showed no significant variation (Table 6).

**Table 6: Comparison of Mean±SD of White Cell Indices of Subjects with Malaria after Treatment**

	AGE (Years)	WBC( $10^9/L$ )	LYM (%)	MID (%)	GRA (%)
Before treatment (n= 61)	13.79 ±1.62	5.19 ± 1.45	49.84 ± 9.4	14.22 ± 6.4	35.94 ±6.94
After treatment (n= 61)	13.67 ±1.32	4.32± 1.23	44.46 ±5.37	14.27 ±4.02	41.34 ± 5
p-value	0.686	0.0001*	0.005*	0.961	0.961

**Key:** WBC - White blood cell, LYM –Lymphocyte, MID - Mid cell, GRA - Granulocyte  
\*- Significant

#### Comparison of Mean ± SD of Red Cell and Platelet Indices of Subjects with Malaria after Treatment

Comparison of red blood cell and platelet indices of subjects with malaria before and after treatment showed

statistically significant decrease in haematocrit ( $p=0.017$ ), with increase in the mean cell volume (MCV), mean cell haemoglobin (MCH) and platelet distribution width ( $p=0.0001$ ,  $p=0.0001$  and  $p=0.007$ , respectively) after treatment. Other parameters such as haemoglobin, mean cell haemoglobin concentration, red cell distribution width and platelets had no significant mean variation after treatment (Table 7).

**Table 7: Comparison of Mean ± SD of Red Cell and Platelet Indices of Subjects with Malaria after Treatment.**

	HGB(g/dL)	HCT(%)	MCV(fl)	MCH(pg)	MCHC(g/dL)	RDW(%)	PLT( $10^9/L$ )	PDW(%)
Before treatment(n= 61)	11.15±1.29	36.19±5.18	80.03±5.3	25.09±1.76	31.31±0.60	15.44±0.86	244.7±62.17	39.4±1.57
After treatment (n= 61)	10.8±1.03	34.42±3.64	86.16±8.09	26.99±2.62	31.4±0.77	15.23±0.82	230.6±54.57	40.2±1.63
p-value	0.108	0.017*	0.0001*	0.0001*	0.431	0.136	0.158	0.007*

**Key:** HGB – haemoglobin, HCT – haematocrit, MCV – mean cell volume, MCH – Mean cell haemoglobin, MCHC – mean cell haemoglobin concentration, RDW – red cell distribution width, PLT – platelets, PDW – platelets distribution width, \* - Significant.

#### Effect of Gender on White Cell Indices of Subjects after Treatment

In males, there was statistically significant increase in mean values of white blood cell and mid cell ( $P=0.0002$  and  $p=0.0001$ , respectively), with decreased granulocytes ( $p=0.040$ ) when compared to females (Table 8).

**Table 8: Effect of Gender on White Cell Indices of Subjects after Treatment.**

After Treatment	AGE(YEARS)	WBC( $10^9/L$ )	LYM %	MID%	GRA%
Females (n=27)	13.8±1.85	3.72 ± 1.09	45.18 ± 3.1	12.02 ± 3.5	42.68 ±3.39
Males (n=34)	13.53±1.3	4.86 ± 1.11	43.81 ±6.81	16.31 ±3.35	40.12 ±5.89
p-values	0.477	0.0002*	0.312	0.0001*	0.040*

**Key:** WBC - White blood cell, LYM –Lymphocyte, MID - Mid cell, GRA - Granulocyte  
\*- Significant  $P<0.05$

#### Effect of Gender on Red Cell and Platelet Indices of Subjects after Treatment

Comparison of red blood cell and platelet indices between males and females after treatment, showed that

females had significantly higher mean values of mean cell volume (MCV), mean cell haemoglobin (MCH) and mean cell haemoglobin concentration (MCHC) ( $p=0.001$ ,  $p=0.001$  and  $p=0.026$ , respectively); while males have higher mean value of platelet ( $P>0.05$ ), with increase in the mean value of PDW ( $p=0.049$ ) after treatment (Table 9).

**Table 9: Effect of Gender on Red Cell and Platelet Indices of Subjects after Treatment.**

After treatment	HGB(g/dL)	HCT(%)	MCV (fl)	MCH (pg)	MCHC(g/dL)	RDW(%)	PLT( $10^9/L$ )	PDW(%)
Females (n = 27)	10.72±1.03	33.94±3.19	89.83±8.9	28.49±2.8	31.63 ±0.84	15.09±0.91	224.9 ± 54.5	39.77±1.71
Males (n=34)	10.87 ± 1.05	34.86 ± 4.0	82.84 ±5.49	25.62 ±1.52	31.19 ± 0.63	15.35 0.72	235.8 54.9	40.6 ± 1.48
p-value	0.597	0.323	0.001*	0.001*	0.026*	0.221	0.438	0.049*

**Key:** HGB – haemoglobin, HCT – haematocrit, MCV – mean cell volume, MCH – Mean cell haemoglobin, MCHC – mean cell haemoglobin concentration, RDW – red cell distribution width, PLT – platelets, PDW – platelets distribution width, \* - Significant.

#### DISCUSSION

From this study, there was significantly reduced haematocrit, haemoglobin concentration, red cell distribution width and platelet distribution width in

malaria infected subject compared to the healthy control group at baseline. This is in accordance with other studies which reported reduced haematocrit, haemoglobin concentration and platelet in malaria infection.<sup>[12][13]</sup> Malaria has a significant impact on red blood cell due to direct interaction on red blood cell thereby causing destruction of cell especially in young children, the removal of infected and uninfected red cells causes haemolysis due to loss of infected red blood cell this is termed phagocytosis, further destruction can

disrupt immune- modulation and subsequently causing bone marrow dysfunction.

There was also significant reduction in red cell distribution width, these are new findings associated with malaria and could be due to dispersion of red cell sizes causing changes in the sizes of red blood cells, the increase in platelet distribution width after malaria treatment is suggestive of bone marrow involvement in the formation of megakaryocytes, compensatory mechanism is required for decrease in platelet count during malaria infection this is in line with the work of previous researchers.<sup>[14]</sup> We observed that after relapse of fever upon treatment of malaria, the subjects were found to be negative to parasitaemia, there were significant decrease in white blood cell and lymphocytes, lymphopenia is due to reflection in redistribution of lymphocytes accompany with sequestration of the spleen leading to splenomegaly as a result of abnormal immune response.

We observed in this research that after treatment, there was significant reduction in platelet count in adolescents this might be due to association of thrombocytopenia with malaria infection as agrees with a past report which highlighted the direct interaction between *Plasmodium falciparum* and platelets in immune system.<sup>[14]</sup> Furthermore, we recorded no statistical differences in the mean age and white blood cell of the infected subject compared to the control group portraying the fact that age does not affect white blood cell, upon treatment of the infected subjects there was significant increase in white blood cell and lymphocyte.

The relationship between gender and immune response were however demonstrated by comparing the white blood cell of male and female, following malaria infection there was significant increase in white blood cell, haematocrit, haemoglobin concentration, red cell distribution width and platelet with marked lymphopenia in male compared to their female counterpart. This agree with the work done by other researchers which support the fact that females have a better immunity to parasitic infection compared to the male, however there is significant increase in lymphocytes in female than male.<sup>[15][16]</sup> Following treatment of the infected subjects with antimalaria there were significant increase in white blood cell, mid cell and granulocyte in infected male compared to the female.

## CONCLUSION

At baseline (before treatment), there was significantly lower haemoglobin, haematocrit, red cell distribution width and platelet distribution width among the infected subjects when compared to control group. Males had higher total white blood cell count, haemoglobin concentration, haematocrit, red cell distribution width and platelet distribution width when compared to females.

After treatment of the infection, there was significantly decreased Total white blood cell count, lymphocytes and haematocrit; with increased mean cell volume, mean cell haemoglobin and platelet distribution width. Also, males had significantly higher total white blood cell count, mid cell and platelet distribution width; with lower granulocytes, mean cell volume, mean cell haemoglobin, mean cell haemoglobin concentration when compared to females after treatment.

**Recommendations:** Considering our finding that malaria infection affects the blood indices of infected individuals, there is need for health promotion and education campaigns to enlightening the masses on the strategies for prevention and management of malaria infection. Also, parents should be encouraged to ensure that children infected with malaria adhere strictly to recommended malaria therapy to prevent drug resistant malaria strains.

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