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Prevalence of Plasmodium falciparum and its impact on Haematological Parameters in Children attending LAUTECH Teaching Hospital Osogbo, Osun State, Nigeria.

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ABSTRACT

Malaria is a major problem in children particularly in developing countries. High mortality is usually compounded by various haematological complications if left untreated. The aim of this study was to determine the prevalence of *P. falciparum* and it's impact on haematological parameters in children at LAUTECH Teaching Hospital Osogbo. Five milliters of blood each was collected through the peripheral vein of consenting 300 children into Ethylenedimethyltetraacetic acid (EDTA) bottles. Thin and thick blood films were made and were stained with Giemsa's stain for microscopy and also Rapid Diagnostic Test (RDT) method was used for the detection of *P.falciparum*. Haematological parameters such as White Blood Cells (WBCs), Red Blood Cells (RBCs), Haemoglobin level, Platelet counts and Packed Cell Volume (PCV) were determined while Mean Cell Volume (MCV), Mean Cell Haemoglobin (MCH), Mean Cell Haemoglobin Concentration (MCHC) and Red Cell Distribution Width (RDW) were estimated using Mindray blood analyzer. Data were analysed using Analysis of Variance (ANOVA). Out of 300 children screened for malaria, 36 (12.0%) were positive by RDT while 44 (14.6%) were positive by microscopy. The total number of male in the study was 153 (51%) out of which 30 (10%) were positive and the total number of female in the study were 147 (49%), out of which 14(4.7%) were positive.The total mean parasite density in this study was 7945.45p/µl of blood. Age group 5-10 years recorded the highest mean parasite density of 9722.22p/µl and the difference was statistically significant (P = 0.001). The mean platelet counts for malaria positive group (247.76 ± 125.26 × 10^3/µl) was lower than in the malaria non infected group (292.79 ± 136.38 × 10^3/µl) but the difference was not statistically significant (P = 0.062). The total mean leucocyte counts in malaria infected group (9.36.36 × 10^3/µl) was not statistically different from that of the non-malaria infected group (10.47 ± 8.60) (P = 0.45). A significant difference was observed in the mean haemoglobin of malaria infected group (11.25 ± 3.18) compared with malaria non-infected group (12.25 ± 3.18) (P = 0.025). The PCV was also lowered in the malaria infected group (32.84 ± 7.68) when compared with malaria non-infected group (35.79 ± 4.93) (P =0.026) and it was statistically significant. The mean eosinophil count of the malaria infected group was higher (2.45 ± 2.52) than that of the non-malaria infected group (1.85 ± 2.10) but the difference was not statistically significant (P = 0.117). The mean lymphocyte count of the malaria infected group was lower (37.78 ± 17.53) than that of the malaria non-infected group (41.03 ± 17.86) but the difference was not statistically significant (P =0. 305). In conclusion, results from this study showed haematological changes in children infected with malaria. Hence, there is a need for full blood count to be included in the routine test for malaria to know the extent of the infection on haematological parameters.

Keyword: *Plasmodium falciparum*, Haematological parameters, Children, Osogbo

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1. INTRODUCTION

According to the most recent data from World Health Organization (WHO), malaria alone accounts for an estimated 250 to 500 million febrile illnesses and causes about a million deaths annually (WHO, 2021). Malaria is a major public health problem and cause of suffering and premature death in tropical and subtropical countries (Cheesbrough, 2003). It is a major cause of illness and death in children and it was estimated that more than one million children living in Africa die yearly from direct and indirect effects of malaria infection (Fawole & Onadeko, 2001). This preventable disease has reached epidemic proportions in many regions of the world and continues to spread unchecked (WHO, 2000). Previous study has shown that malaria or malaria- helminthes co –infected individuals had significant higher prevalence of anaemia and negative effect on Plasma Cell Volume (PCV) and haemoglobin concentration (Njua-Yafi *et al.,* 2016).

African children under five years and pregnant women are most at risk of malaria. Fatally afflicted children often die less than 72 hours after developing symptoms. Malaria still kills more people than HIV/AIDS or any other killer disease and it is endemic throughout Nigeria accounting for 25% of infant mortality and 30% of childhood mortality (Federal Ministry of Health (FMoH) 2006). About 50% of the population has at least one episode of malaria each year. The economic impact of malaria has been estimated to cost Africa US$12 billion every year (WHO, 2000). The economic impact includes costs of health care, working days lost due to sickness, day lost in education, decreased productivity due to brain damage from cerebral malaria, loss of investment, tourism and diversion of household resources (Greenwood *et al*., 2005).

In Nigeria, the economic impact of malaria can be attributed to low gross national income per capital (GNI) of US$260 (FMoH, 2006). In those children who survive, malaria drains vital nutrients from them impairing their physical and intellectual development (WHO, 2000). About 40% of the world's population lives in malaria endemic areas. 3million-500 million clinical cases are being reported per year and 1.5-2.7 million deaths of which 90% is from Africa (Christopher *et al*., 2012). Malaria is a parasitic disease caused by single celled protozoan parasites of the genus *Plasmodium* belonging to phylum apicomplexan (Krief *et al.,* 2010).

The *Plasmodium* species responsible for malaria infections in Nigeria are *Plasmodium falciparum, Plasmodium malariae and Plasmodium ovale.* Over 80% of malaria infections are caused by *P. falciparum* while up to 15% are caused by *P. malariae* and less than 5% are caused by *P*. ovale infections. Mixed infections with *P. falciparum* are common (FMoH 1990, Orajaka, (1996). Almost 85% of the nearly 500 million annual malaria cases occur in sub-Saharan Africa and about 85% of cases in Africa are caused by *P. falciparum* with the remaining cases being caused by the other three strains (Lock *et al.*, 1997).

Haematological changes are some of the most common complications in malaria and they play a major role in malaria pathology (Maina *et al*., 2010).These changes involve the major cell lines such as red blood cells, leucocytes and thrombocytes (Bakhubaira, 2013). Severe anaemia is the predominant severe malaria syndrome peaking in the first five years of life. In malaria-infected patients, prompt and accurate diagnosis is key to effective disease management for a favourable outcome.

Clinical diagnosis is widely used for diagnosis of malaria especially in resource-poor countries. In tropical countries where malaria is most prevalent, it may be difficult to distinguish the disease from other infections e.g. viral or bacterial based on the symptoms and signs (WHO, 2000). Presumptive anti-malarial treatment is widely practiced and studies show that it is wrought with significant misuse of anti-malarial drugs. Microscopic diagnosis is the "imperfect gold standard" for malaria parasite detection and speciation (WHO, 2010).

Haematological changes in malaria, such as anaemia, thrombocytopenia and leukocytosis or leucopenia are well recognized (Manas *et al*., 2014). The extent of these alterations varies with level of malaria endemicity, background haemoglobinopathy, nutritional status, demographic factors and malaria immunity. Diagnostic value of these haematological alterations has not been established in children living in malaria endemic areas. Clinical diagnosis is imprecise but remains the basis of diagnosis in most endemic areas where laboratory support is often out of reach. Children under five years of age being the most affected group, haematological changes that occur during malaria infection have been suggested as potential predictors and can aid in the diagnosis of malaria. The aim of the research is to determine the prevalence of malaria among children and its haematological changes in the study area.

2. MATERIALS AND METHODS

Study Area

The study was carried out at Ladoke Akintola University of Technology Teaching Hospital Osogbo, Osun state.

Study Population

Patients (≤10 years) who presented with malaria at the outpatient department of LAUTECH Teaching Hospital Osogbo, were recruited into the study.

Inclusion Criteria: People living within the study area, children ≤ 10 years of age

Exclusion Criteria: Patients above the age of 10 years, patients that have taken antimalarial drugs.

Sample size calculation

Leslie Fisher's formula in Ojurongbe *et al*., (2013) was used for sample size calculation

$$n = \frac{t^2 \times p\,(1-p)}{m^2}$$

Description:

n = required sample size

t = confidence level at 95% (standard value of 1.96)

p = estimated prevalence of the disease/infection in the project area is 76% (Onyiri *et al*., 2015).

m= margin of error (0.05).

n= 383.9

The minimum sample size calculated was 383.9. The sample size was increased to 400 to cater for anticipated non-response individuals. Control samples were taken from negative samples.

Ethical issue
Ethical approval was obtained from the Ethical Committee of LAUTECH Teaching Hospital Osogbo. Informed consent was obtained from the children's parent or guardian.

Blood sample collection
A suitable site for vene puncture was selected by placing the tourniquet above the selected puncture site on the patient. The tourniquet was not put too tightly on or left on the patient longer than 1minutes. The area of the vein selected was cleansed using methylated spirit in a circular motion beginning at the site and working outward. The area was allowed to air dry. The patient was asked to make a fist and the needle was swiftly inserted through the skin into the lumen of the vein. The needle formed a 15-30 degree angle with the arm surface. Blood was withdrawn to the 5ml mark on the syringe. The tourniquet was removed and the needle was removed from the patient's arm using a swift backward motion. Cotton wool was placed immediately on the puncture site. The needle was removed from the syringe; blood was dispensed into the sample bottle and was mixed immediately.

Smear Preparation
Thick Blood Smear Preparation
A drop of blood was put on a clean grease free slide; the corner of a clean slide was used to spread the drop of a blood in the circle size of a dime (diameter 1-2cm). The smear made was not too thick or it will fall off the slide. The smear was allowed to air dry thoroughly so as not to detach from the slides during staining.

Thin Blood Smear Preparation/ staining
A drop of blood was put on a clean grease free slide, a clean spreader was held at 45^{o}angle towards the drop of blood on the specimen slide. I waited until the drop of blood spreads along the same angle and the spreader was pushed forward rapidly and smoothly. The films were air dried completely before staining. The slides were fixed in absolute methanol for 15-30 seconds and were allowed to air dry completely before staining. The slides were placed in working Giemsa's stain 5% for 10minutes. The thin smear slides were removed and rinsed by dipping 3-4 times in the Giemsa buffer. Thick smears were left in the buffer for 5 minutes. The slides were dried upright in a rack.

Microscopic Examination
The thin and thick smear were first screened at low magnification (10× or 20× objective lens), to detect large parasites (microfilaria), then the smears were examined using oil immersion objective. At least 300 oil immersion fields were examined for the determination of no parasite seen.

Procedure for RDT
Carestat kit that detects Histidine Rich Protein 2 (HRP2) of *Plasmodium falciparum* was used. The expiry date of the test kit seal was checked. All logistics needed for the test were assembled. The cassettes were labeled with the patient's identification number. The forth finger was disinfected and allowed to air dry. The disinfected finger was pricked and the first drop of blood was wiped with dry cotton wool. Capillary tube was held vertically to draw whole blood specimen. Blood was transferred into the sample well marked (S) on the cassette. Two drops of buffer was dropped into the buffer whole in the cassette. Results were read within a minimum of 15 minutes and maximum of 30 minutes.

Parasitological assessment of the blood samples

Parasites were counted against 200 white blood cells (WBCs) from the thick film. The parasite density was obtained by assuming a total WBC count of 8000/mL and at least 200 fields were examined before being taken as a negative result (WHO, 2010)

Haematological assessment: Mindray Blood Analyzer was used for the estimation of White Blood Cells (WBC), Red Blood Cells (RBC), haemoglobin level, platelet counts, Mean Cell Volume (MCV), Mean Cell Haemoglobin (MCH),Mean Cell Haemoglobin Concentration (MCHC), Red Cell Distribution Width (RDW), haematocrit, differential count.

3. RESULT

The total number of subjects in this research was 300 children. The ratio of the male subject to the female subject was 153: 147; the mean age in years was 5.5. The total number of subjects that was positive for microscopy was 44 which represents 14.7% of the total population while the number positive with RDT was 36 which represents 12% of the total population. The mean PCV for *P. falciparum* infected individuals was 32.95 while the mean PCV for *P. falciparum* non-infected individual was 34.82 (Table 1).

From the total number of 153 male subjects, those less than the age of 1 year was 41 and 15(5%) were positive. Those from the age of 1-5years were 67 and only 3 were positive representing 0.9%. Those within the age range of 6-10 years were 45 and 12 were positive. From the total number of 147 female subjects those less than one year of age were 47 out of which 4(1.3%) were positive. Those within the age range 1-5 years were 47 out of which 8(2.7%) were positive. Those within the age range of 8-10 years were 53 out of which 2 were positive (Table 2).

The total number of subjects within the age range of less than 1 year were 88, out of which 19(6.3%) were positive for RDT. Within the age range of 1-5 years 144 were examined, out of which 11 (3.7%) were positive with microscopy method and 9 (3.0%) were positive using RDT method. The total number of subject within the age group of 6-10 years were 98,out of which 14(4.6%0 were positive using microscopy method and 14(4.7%) were positive using RDT method (Table 3). Table 4 shows the mean distribution of haematological parameters in relation to MCV, MCH, MCHC, RDW CV, and RDW SD respectively.

In this table, the increase in haematological parameters of MCV (75.88±11.56), MCHC (37.03±29.19) and RDW SD (49.30±48.11) in the non- infected group to MCV (74.87±16.112), MCHC (34.08±1.50) and RDW SD (43.32±8.64) were not statistically significant compared to the positive group (P=0.64, 0.54, 0.46 respectively). Also the decrease observed in the mean of MCH (25.78±3.86) in the negative group compared to the positive group (26.78±4.67) is not statistically significant at $P<0.05$. There is no statistically significant change in the mean of RDW CV (0.14±0.03) in the non-infected group when compared to the positive group at $P<0.05$.

Table 5 shows the haematological parameters such as platelet count, MPV, PDW, PCT, HGB and HCT. In the table, a significant decrease was observed in the mean of MPV (9.48±0.88), haemoglobin (11.25±3. 18) and haematocrit (35.79±4.93) of the malaria infected group compared to the non-malaria infected group (9.04±0.99) and (32.84±7.68) and the differences were statistically significant at P <0.05. Decrease in RBC (4.39±0.44) and (4.94±1. 06) of the malaria infected group compared to that of non-malaria infected group was not statistically significant. Also, there was reduction in the mean platelet count, PDW and PCT (247.76±125.26), (15. 12±3.35) and (2.46±0.94) respectively was not statistically significant as compared with the mean of platelet count PDW and PCT (292.79±136.38),(16.78±12. 11) and (2.62±1.06) respectively at P<0.05.

Table 6 shows leucocyte and differential of the study groups. There is decrease (9.36±5.59) in the leucocyte count of the positive group, although it is not statistically significant (P=0.45). There is also a decrease in mean lymphocyte (37.78±17.53),mean monocyte count (6.38±5.25) and mean basophil count (0.77±0.45) count of the positive group compared to the negative group respectively and they are not statistically significant (P=0.31, 0.98, 0.76 respectively). Table 7 shows the association between age and sex with the test group. A significant association was observed between sex and the test group (X^2=5.109, P=0.018) while the association between test group and age group was non-significant (X^2=2.945, P=0.229). Table 8 shows the association of malaria infection on blood group in relation to age. In the table, a significant association was observed between sex and blood group in the negative group at P=0.001. A non- significant association was observed between sex and blood group within the positive group at P=0.072.

Table 1: General characteristics of the subjects in relation to *Plasmodium falciparum* parasitemia

Subject characteristics	No infected (Prevalence)
Male: Female	153:147
Mean age (years)	5.45
No positive for microscopy	44(14.7)
No positive for RDT	36(12)
Mean PCV for *P. falciparum* infected individuals	32.95
Mean PCV for non- infected individuals	34.82

Number of subject is 300.

Table 2: Prevalence of *Plasmodium falciparum* among children in relation to sex and age using the gold standard

	MALE		FEMALE	
AGE (YEAR)	NO EXAMINED	No Infected &Prevalence (%)	NO EXAMINED	No Infected& Prevalence (%)
<1	41	15(5%)	47	4(1.3%)
1-5	67	3(0.9%)	47	8(2.7%)
6-10	45	12(4.0%)	53	2(0.6%)
TOTAL	153	30(10%)	147	14(4.7%)

Table 3: Prevalence of *Plasmodium falciparum* among children in relation to age and diagnostic methods

		Microscopy	RDT
Age	No Examined	No Infected (Prevalence)	No of Positive (Prevalence)
< 1 year	88	19(6.3%)	13 (4.3%)
1-5	114	11(3.7%)	9(3.0%)
6-10	98	14(4.67%)	14(4.7%)
Total	300	44(14.6%)	36(12.0%)

Table 4: Malaria in relation to haematological parameters

GROUP	GENDER	MCV (fl)	MCH (Pg)	MCHC (g/dl)	RDWCV	RDWSD (fl)
Negative	Female	76.08±13.26	26.48±3.89	38.46±37.46	0.14±0.03	49.54±48.18
	Male	75.65±9.29	25.39±3.76	35.39±14.87	0.14±0.03	49.03±48.23
	Total	75.88±11.56	25.98±3.86	37.03±29.19	0.14±0.03	49.30±48.11
Positive	Female	79.18±6.60	25.77±4.05	33.80±1.59	0.16±0.07	45.32±7.71
	Male	72.71±18.97	27.29±4.95	34.23±1.47	0.13±0.01	42.33±9.06
	Total	74.87±16.12	26.78±4.67	34.08±1.50	0.14±0.04	43.32±8.64
Total	Female	76.32±12.88	26.42±3.89	38.09±35.98	0.14±0.03	49.21±46.30
	Male	75.17±11.40	25.71±4.03	35.20±13.61	0.14±0.02	47.94±44.30
	Total	75.76±12.17	26.08±3.97	36.67±27.40	0.14±0.03	48.59±45.26
P- Value		0.641	0.255	0.546	0.622	0.458

Table 5: Malaria infection in relation to platelet estimation

Group		PLATLET (10^3mLx10^3)	MPV(FL)	PDW	PCT (ML/L)	RBC (10^2/L)	HGB (g/dl)	HCT(%)
Negative	Female	274.10±130.71	9.12±0.92	15.80±0.50	2.55±1.03	4.54±1.29	12.59±3.91	36.60±6.7
	Male	314.58±140.11	8.95±1.07	17.91±17.70	2.69±1.09	4.40±0.70	12.86±2.00	35.38±3.85
	Total	292.79±136.38	9.04±0.99	16.78±12.11	2.62±1.06	4.94±1.06	12.25±3.18	35.79±4.93
Positive	Female	268.33±139.39	9.20±0.87	15.98±0.54	2.38±1.00	4.21±0.63	11.38±2.39	33.17±8.95
	Male	237.47±119.39	9.63±0.86	14.69±4.05	2.51±0.92	4.18±0.31	11.15±1.77	32.46±5.92
	Total	247.76±125.26	9.48±0.88	15.12±3.35	2.46±0.94	4.39±0.44	11.25±3.18	32.84±7.68
Total	Female	273.65±130.93	9.13±0.91	15.81±0.51	2.54±1.03	4.45±1.25	11.66±3.81	33.44±8.82
	Male	301.82±139.51	9.06±1.07	17.39±16.31	2.66±1.07	4.33±0.66	11.07±2.02	32.93±5.73
	Total	287.35±135.68	9.09±0.99	16.58±11.43	2.60±1.05	4.39±1.01	11.37±3.08	33.19±7.46
P- Value		0.062	0.012	0.414	0.405	0.403	0.025	0.026

Table 6: Malaria in relation to White Blood Cell differentials

Group		WBC	Neutrophil	Lymphocyte	Monocyte	Eosinophil	Basophil
Negative	Female	11.69±10.80	49.20±18.82	39.35±19.16	6.43±4.01	1.80±1.96	0.91±1.44
	Male	9.06±4.69	48.04±16.88	42.96±16.12	6.38±3.84	1.90±2.25	0.73±0.52
	Total	10.47±8.60	48.66±17.92	41.03±17.86	6.41±3.92	1.85±2.10	0.82±1.12
Positive	Female	10.08±3.75	58.13±15.37	33.83±16.06	5.57±3.04	1.72±1.08	0.75±0.57
	Male	9.00±6.36	49.89±21.88	39.75±18.22	6.79±6.09	2.82±2.94	0.78±0.40
	Total	9.36±5.59	52.64±20.11	37.78±17.53	6.38±5.25	2.45±2.52	0.77±0.45
Total	Female	11.56±10.42	49.90±18.68	38.92±18.95	6.36±3.94	1.80±1.91	0.90±1.40
	Male	9.05±4.98	48.35±17.72	42.44±16.46	6.45±4.26	2.05±2.39	0.73±0.50
	Total	10.33±8.30	49.14±18.20	40.64±17.83	6.40±4.09	1.92±2.15	0.82±1.06
P- Value		0.453	0.219	0.305	0.976	0.117	0.76

Table 7: Association between the age and sex with the test group

		Negative	Positive	Total	Pearson Chi-Square	df	Asymp. Sig. (2-sided)
Age group	1 - 5 Years	105	9	114	2.945[a]	2	0.229
	6 - 10 Years	84	14	98			
	less than one year	75	13	88			
	Total	264	36	300			
Sex	Female	141	12	153	5.109[a]	1	0.018
	Male	123	24	147			
	Total	264	36	300			

Table 8: Association of malaria infection on blood group in relation to age

			< I year	1 - 5 Years	6-10 Years	Total	P Value
Negative	Blood Group	ABPositive	6	2	0	8	.001
		A Negative	2	0	0	2	
		A Positive	8	26	19	53	
		B Positive	30	22	20	72	
		O Negative	0	2	2	4	
		O Positive	29	53	43	125	
	Total		75	105	84	264	
Positive	Blood Group	A Positive	0	0	4	4	.072
		B Positive	4	2	2	8	
		O Negative	0	0	2	2	
		O Positive	9	7	6	22	
	Total		13	9	14	36	
Total	Blood Group	AB Positive	6	2	0	8	.000
		A Negative	2	0	0	2	
		A Positive	8	26	23	57	
		B Positive	34	24	22	80	
		O Negative	0	2	4	6	
		OPositive	38	60	49	147	
	Total		88	114	98	300	

4. DISCUSSION AND CONCLUSION

The main methods for diagnosing malaria are microscopy, antigen test, symptomatic and molecular methods. In this study a comparison of diagnosing malaria was based on microscopy and Rapid Diagnostic Test (RDT) among children within age range less or equal to ten years. In this study, large percentage of malaria parasite was observed using microscopy test compared to RDT. The decreased number of positivity in RDT could be as a result of decrease in sensitivity of the kit to malaria parasite or because the kit can only aid in the detection of histidine –rich protein 2(HRP2) of *P. falciparum.* This finding is in line with the findings of Wongrischanalai *et al*., (2007) who reported the use of microscopy in the diagnosis of malaria at peripheral level is the most widely used tool and more sensitive to diagnosis of malaria compared to other related methods of diagnosis such as RDT.

This finding also corroborates with the findings of Hopkins *et al*., (2008) and Wongsrichanalai *et al*., (2007) who jointly reported a high sensitivity in malaria diagnosis with microscopy following the use of RDT and microscopy in the diagnosis of malaria in a study on review of malaria diagnostic tools microscopy and rapid diagnostic tests. This is also in line with the findings of Ojurongbe *et al*., (2013) in their work reported that 48% were positive for thick film microscopy while 38.7% were positive for RDT. This finding is also supported by the work of Onyeka *et al*., (2015) submitted that Care start kit is not as sensitive as microscopy in the diagnosis of malaria parasite. Also, Oyetunde *et al*., 2015 recorded that the prevalence of malaria obtained through microscopy (66.8%) was significantly higher in RDT (36.8%).

This is in contrast with the findings of Batwala *et al*., (2011) who revealed that the sensitivity of RDT was significantly higher than that of other techniques and was excellent in children. Haematocrit is considered as an integral part of a person complete blood count result. The measure of a person haematocrit levels can indicate possible disease and a low level below the reference range may suggest anaemia. In this study, the mean PCV of the subject positive to malaria parasite is lower compared to the non- infected subjects. This findings is in line with the findings of Mahmood and Yasir (2013) who reported changes in some haematological parameters following infection with malaria and also in line with the findings of Okafor and Nwaiwu (2001) who also reported that the association between malaria parasite counts in a subject is inversely associated with PCV in the study of anaemia of persistent malaria parasitaemia in Nigerian children.

In this study the overall prevalence of malaria based on microscopy was 14.6%. This prevalence of malaria was high as compared to 12.0% using RDT diagnosis techniques. This prevalence is however lower than the national prevalence of 20% in certain areas of Nigeria to over 70% in others as reported by Onyiri (2015). This difference could be attributed to the relentless efforts of Nigeria governments, non-governmental organization organization on primary health care towards ensuring control of malaria through distribution of insecticide treated bed nets to all households in the country and also sensitization through media. Also this decrease observed in the trend of malaria parasite could be attributed to geographical settings. However the prevalence of malaria parasite does not differ between male and female subjects which are in consistent with other studies such as Ndong *et al*., (2014) who reported no significance difference in prevalence of malaria infection among females and males subject in a study on malaria and helminth co-infection in school children.

Changes in haematological parameters are likely to be influenced by any disease condition including endemic disease such as malaria. Haematological changes such as MCV, MCH, MCHC, RDWCV and RDWSD play a major role in the pathogenesis of malaria infection. In this study, reduction was observed in the mean of MCV, MCH, MCHC, RDWCV and RDWSD among the infected subjects compared to the negative subjects but the difference was not statistically significant. This decrease observed in the MCV, MCH, MCHC, RDWCV and RDWSD among infected subjects could be as a result of protective effect of the haematological parameters as most are being mobilized to foreign infection or disease state in the body among which could include malaria. This finding is in line with the findings of Manas *et al*., (2014), who submitted a decrease in the mean of MCV,MCHC, RBC and Haemoglobin in malaria infected subject in a study on effect of malaria on haematological parameters in population and also in line with the findings of Kitua, (1997) who also reported a significant decrease in haematological parameters of MCV, MCHC, RBC, RDW in a study on *Plasmodium falciparum* parasitemia in anaemia among infants living in an area of intense and perennial transmission.

Blood platelet levels are being used as a predictive and prognostic indicator of the severity of malaria infections in humans. In this study the reduction in the mean platelet count among the *P. falciparum* infected subjects when compared with non-infected subjects was not statistically significant. The reduction in platelet count observed among *Plasmodium falciparum* infected individuals could be as a result of thrombocytopenia in malaria which have occurred as a result of pathological effect of malaria on platelet through peripheral destruction, sequestration on excessive removal of the platelet by the spleen, as well as platelet consumption by the process of disseminated intravascular coagulation. The finding corresponds to the report of Mayyada *et al*., (2012), who reported that platelet count were significantly lower in patients with malaria in a study on platelet count in *P. falciparum* in an area of unstable malaria transmission.

Inflammatory markers such as WBC, lymphocyte, basophil monocyte, neutrophil and eosinophil have been reported to be associated with most disease state and inflammation following exposure to an infectious disease. In this study, changes were observed in the markers of inflammation among infected subjects. There is a decrease in the mean of WBC, lymphocyte, basophil and monocyte among infected subjects. Also, increased in the mean of neutrophil and eosinophil was observed in the infected subjects. This increase in the inflammatory makers of neutrophil and eosinophil observed among infected subject could be as a result of increase synthesis of inflammatory makers of neutrophil and eosinophil among *P. falciparum* infected subjects.

In this study a significant decrease in the mean RBC in the test group compared to control. This decrease could be as a result of malaria infection within the study subjects. This finding is in line with the findings of Manas *et al.,* (2014), who reported a significant decrease in RBC of malaria infected subjects. This study also, shows a significant decrease in the mean leucocyte count, platelet count of malaria infected patients which is in concordance with the work of Zeeba *et al*., (2014) and that of Njunda *et al.,* (2016), Squire *et al.,*(2014) and Richard and Elena(2012). Furthermore, there was also a decrease in the mean value of the red cell lines MCV, MCHC, MCH in malaria infected subjects as reported by Njunda *et al*., (2016). In addition, there is significant increase in the mean neutrophil count of malaria infected children as reported by (Squire *et al*., 2014) in their work effect of *P. falciparum* malaria parasites on haematological parameters in Ghanaian children.

There is significant decrease in lymphocyte, monocyte and basophil of malaria in infected children as reported by Squire *et al*., 2014. There is also a decrease in mean of eosinophil count which is in agreement with the work of Maina *et al*., (2010). Also, in the present study, mean RDW values were found to be lower in the malaria group compared to the non-malaria group which is the same with the findings of Zeeba *et al*., (2014) but not in agreement with Lathia and Joshi (2004). In conclusion, results from this study showed haematological disorders in children infected with malaria. Hence, there is a need for full blood count to be included in the routine test for malaria to know the extent of the infection on haematological parameters.

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