Prevalence of Asymptomatic Malaria in Relation to Haematological Parameters among Children Attending General Hospital, Minna, Nigeria

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Abstract

Asymptomatic *Plasmodium falciparum* parasitaemia (APFP) has been reported to be highly prevalent in Sub-Saharan Africa, a region heavily burdened by malaria; yet, the impact of APFP on the haematological reference values have not yet been established in Minna. This study was therefore designed to evaluate the prevalence of asymptomatic malaria in relation to haematological parameters among children attending General Hospital, Minna, Nigeria. After informed consent and clinical examination, blood samples were obtained from the participants for malaria diagnosis and a full blood count. The diagnosis of malaria was confirmed by thick and thin films stained with Giemsa's for malaria parasite and Complete Blood Counts (CBCs) were performed using an automated Abacus Junior machine. Of the 201 subjects sampled, the Age group 1-5years showed the highest prevalence of 24 (13.82%) for the symptomatic patients, followed by the age group 6-10years 3 (2.32%).The least prevalence of 1(2.86%) for the symptomatic patient was in the age group above 11years. The male symptomatic and asymptomatic subjects have higher gender prevalence characteristics of malaria parasite 20 (14.49%) than the female 8 (12.70%), though this difference was not significant ($P>0.05$). The Chi-square analysis between the groups showed association among the gender with a value of 0.4919 at 5% level of significance. Patients with symptomatic parasitaemia tended to have significantly ($P<0.05$) lower lymphocyte percentage (25.15±2.45), Red blood cell count (RBC) (4.14±0.21), Haemoglobin (HB)(8.81±0.44), Corpuscular Haemoglobin (MCH) (23.97±1.57) compared to that of asymptomatic and non-infected subjects. Corpuscular haemoglobin concentration (MCHC), Red Cell Distribution Width (RDWC), Platelet Volume (MPV) and Platelet Distribution Width showed no significant difference ($P>0.05$). Platelet Count was, however, higher (269.57±6.93) significantly ($P<0.05$) in non-infected control group compared to that of symptomatic and asymptomatic subjects with reduced platelet counts (140.36±13.09 and 123.63±6.99), respectively. Gender prevalence characteristics showed significance ($P<0.05$) in platelet count (276.03±8.21, 255.88±12.72) in normal male and female subjects, respectively, compared to other groups. Among the malaria parasite density groups, least lymphocyte count (1.34±0.21) was found in 5001-10000mp/µl, symptomatic subjects. The mean Platelet Count was significantly lower in the asymptomatic density group compared to that of symptomatic malaria density group. This study confirms that haematological changes are frequent in asymptomatic plasmodial infection. Special attention should be applied when interpreting haematological parameters and evaluating immune responses in children living in malaria endemic area

Key words: Asymptomatic malaria, Children, Haematological Parameters, Minna, Nigeria.

Introduction

As one of the Millennium Development Goals, malaria abatement has been the target of various poverty-reducing campaigns throughout the developing world. Although the disease is both preventable and curable, it remains a primary and a major public health problem with an estimated two million children worldwide dying of it yearly. Regardless of the fact that it is one of the oldest recorded diseases, malaria remains one of the world's most deadly infectious diseases. It is, arguably, the greatest menace to modern society, in terms of morbidity and mortality. Though preventable, treatable and curable, there is no known immunity. This makes it an efficient and unrepentant killer. Several centuries after its discovery, malaria still remains a devastating human infection, resulting in 300-500 million clinical cases and three million deaths every year (WHO, 2011).

Malaria is endemic throughout Nigeria. It has the greatest prevalence, close to 50%, in children age 6-59 months in the South West, North Central, and North West regions. Malaria, currently, accounts for nearly 110 million clinically diagnosed cases per year, 60 percent of outpatient visits, and 30 percent hospitalizations. An estimated 300,000 children die of malaria each year. It is also believed to contribute up to 11 percent maternal mortality, 25 percent infant mortality, and 30 percent under-five mortality. It is estimated that about 132 billion Naira is lost to malaria annually in the form of treatment costs, prevention and loss of work time in Nigeria (George and Ewelike-Ezeani, 2011).

Malaria is a complex disease due to its complex transmission process. The complexity of the disease vector (the Anopheles mosquito) is only articulated by the complex life cycle of the parasite (Plasmodium). The sub- Saharan African region has the highest number of people exposed to malaria transmission and the highest malaria morbidity and mortality rates in the world (WHO, 2011). Malaria is known to have a negative impact on performance and learning in children (Holding & Snow, 2001). It also aggravates anaemia and malnutrition in children and pregnant women (Murphy & Breman, 2001). It is estimated that, in Africa, malaria is responsible for over one million deaths yearly particularly of infants and young children (Angyo *et al.,* 1996).

According to the World Health Organisation (WHO), the number of annual malaria cases worldwide is actually decreasing, yet the impact of the disease burden remains an enormous challenge, for sheer numbers and threat to human life. Nigeria is one of Africa's hardest-hit, accounting for between 30 and 40 percent of malaria deaths on the continent (WHO, 2007). This magnitude of occurrence in this part of the world correlates with poverty, ignorance and social deprivations in the community (WHO, 2011). On the possible eradication of malaria, Arigbabuwo (2010) opined that prevention is better than cure, advising that people should learn to maintain personal and environmental hygiene. In malaria endemic areas, clinical manifestation of *Plasmodium* infection varies from asymptomatic to severe and fatal malaria. In high transmission areas, continuous exposures to *Plasmodium* infection lead to partial immunity and consequently, create asymptomatic carriers in a given population (WHO, 2011). In addition, asymptomatic cases provide a fundamental reservoir of parasites and they might become gametocyte carriers, contributing to the persistence of malaria transmission (George and Ewelike-Ezeani, 2011). Therefore, the presence of asymptomatic cases is a big challenge for the management of elimination programme in any malaria endemic area. In order to achieve a successful elimination, detection of all parasite carriers, by active case detection, and then treatment of all cases must be considered. There is a paucity of information about asymptomatic malaria in relation to haematological changes in infected Nigerian children and this has necessitated this study in Minna, north-central Nigeria, as the findings can further assist in the management of malaria.

Materials and methods

Description of Study Area

The study was carried out in General Hospital, Minna metropolis, Niger State. Minna, the capital city of Niger State, is located within longitude 6° 33'E and latitude 9° 37'N, covering a land area of 88km2 with an estimated human population of 1.2million (The Nigerian Congress, 2007). It has a tropical climate with mean temperature, relative humidity and rainfall of 30.20C, 61% and 1,334mm respectively. The climate presents two distinct seasons: a rainy season (between April and October, with highest mean monthly rainfall in September) and a dry season (between November and March), completely devoid of rains. The duration of the rainy season is approximately 180 days. Mean maximum temperature remains high throughout the year, hovering about 37.60C. The lowest minimum temperature of 190C occurs usually between December and January, when most part of the state come under the influence of tropical continental air mass which blows from the North.

Its vegetation is typically grass dominated savannah with scattered short trees.

The study was conducted between March and August 2013. Application or consent to conduct the study in the haematology Department of the General Hospital and all other paper works took place between October 2012 and March 2013. The subjects were children attending the general hospital.

Study population

The study population was selected children who accompanied their Parents, relatives or friends to the General Hospital. This study population comprises of asymptomatic Children. The population size was determined using the formula given by Thrusfield (2005), that is, $n = 1.96^2$ where n = the required population which is approximately 384. We could only obtain informed consent of 201 subjects that willingly participated in the research work.

Blood Collection and Laboratory Analysis

Blood was obtained from the peripheral blood of children, using sterile syringe; during which 2mls of whole blood was taken by venous blood collection. The obtained blood was kept in Ethylene-diamine tetra acetic acid (EDTA) bottles for both parasitological and haematological examination. Blood collection was made possible by laboratory Technicians.

Thick Blood Film

The blood film were prepared using the method described by Warhust and William (1996). Three drops of blood were placed 1cm from the edge of a clean glass slide. Another clean slide with smooth edge was used to spread the blood evenly to make a circular patch of moderate thickness. The thick smear of correct thickness was one through which newsprint was barely visible. The slide was allowed to dry for 30 minutes, protecting it from dust. The films were stained with Giemsa.

Thin Blood Film

One drop of blood was placed 1cm from the edge of a clean glass slide. A smooth edge of another clean glass slide touched the blood at an angle of 45^0 and used to spread the blood along the edge. The thin smear was air-dried for 10minutes. Fixing with methanol was followed for 5seconds.

Haematology examination

Haematology parameters, including total white blood cell count, lymphocytes count, medium-size cell count, granulocytes count, red blood cell count, haemoglobin, haematocrit, corpuscular volume, corpuscular haemoglobin, corpuscular haemoglobin concentration, red cell distribution width, platelet count, platelet percentage, platelet volume, platelet distribution width, were determined using an automated differential haematology analyzer (Abacus Junior). All samples were processed within six hours of collection.

Data analysis

Statistical analysis was carried out using SPSS Version 20 Software. A significance level of 5% was used for all tests. The mean values and standard error of the parameters were determined and the differences between the values of haematological parameters of symptomatic, asymptomatic and non-infected children (controls) were assessed using one-way analysis of variance and Duncan Multiple Range Test was employed to separate their means. Parasite densities were also compared against the haematological values, using one-way analysis of variance and Duncan Multiple Range Test was employed to separate their means. Chi-square tests were used to test for the difference between the prevalence of symptomatic and asymptomatic subjects, and ($p<0.05$) was considered significant.

Results

Age Prevalence Characteristics of Malaria

The results of demographic (age) characteristic prevalence of asymptomatic and symptomatic malaria subjects are summarized in Table 1. Of the 201 subjects sampled, the age group 1-5years showed the highest prevalence (19.51%) of 24 positive cases for the symptomatic subjects than age group 6-10years which showed a prevalence (6.98%) of 3 positive cases. The least prevalence (2.86 %) of 1 positive case, for the symptomatic subjects, was in the age group above 11years. However, for the asymptomatic subjects, the least prevalence (4.07%) of 5 positive cases was in the age group 1-5years, while the highest prevalence (25.71%) of 9 positive cases was found in the age group 11 and above. There was, however, a significant difference between prevalence ($p<0.05$) and age groups.

Gender Prevalence Characteristics

The gender prevalence characteristics of the study population are shown in Table 2. The male symptomatic subjects had higher prevalence of malaria parasite [20 (14.49%)] than the female [8 (12.70%)], although no significant difference ($p>0.05$). The male asymptomatic subjects equally had higher prevalence, 12 (8.70%), than

the female, 4 (6.35%). There was also no significant difference (p>0.05).

Table 1: Age Associated Prevalence of Asymptomatic and Symptomatic Malaria in Children attending General Hospital, Minna, Niger State, Nigeria.

		Subjects		
Age	No. Examined	Normal	Asymptomatic	Symptomatic
1-5	123	0 (0.00)	5 (4.07)	24 (19.51)
6-10	43	0 (0.00)	2 (4.65)	3 (6.98)
11-15	35	0 (0.00)	9 (25.71)	1 (2.86)
Total	**201**	**0 (0.00)**	**16 (7.96)**	**28 (13.93)**

Table 2: Gender-related Prevalence of malaria parasites in Children attending General Hospital, Minna, Niger State, Nigeria.

		Subjects		
Gender	No. Examined	Normal	Asymptomatic	Symptomatic
Male	138	0	12 (8.70)	20 (14.49)
Female	63	0	4 (6.35)	8 (12.70)
Total	201		16 (7.96)	28 (13.93)

Haematological Parameters and Prevalence of Asymptomatic and Symptomatic Malaria

The values of eighteen haematological parameters of symptomatic, asymptomatic and non-infected subjects are summarized in Table 3

The value of White Blood Cell Count (WBC), Lymphocyte Count (Lym), and Minimum Inhibitory percentage (MI) were higher in asymptomatic patients than the symptomatic and non-infected subjects, but no significant difference (p>0.05) was observed. The lymphocyte percentage (25.15±2.45) was significantly (p<0.05) lower in the symptomatic subject than the asymptomatic plasmodial infected and non-infected individuals. Also, the Red blood cell count, Haemoglobin, Haematocrit and Corpuscular haemoglobin of the symptomatic patients were significantly lower (P<0.05) than asymptomatic and non-infected subjects; however, Corpuscular haemoglobin concentration, Red Cell Distribution width, Platelet Volume and Platelet Distribution Width showed no significant difference (p>0.05), while platelet count was significantly higher (p<0.05) in non-infected subjects than the symptomatic and asymptomatic subjects with lower/reduced platelet counts (140.36±13.09 and 123.63±6.99), respectively.

Parasite Density Influence on Haematological Parameters

The influence of parasite density of symptomatic and asymptomatic subjects on haematological parameters are presented in Table 4. The values of White Blood Cell Count, Granulocyte Count, Lymphocyte percentage, Granulocyte Percentage, Platelet Volume, Cell Haemoglobin, Corpuscular Haemoglobin, Corpuscular Haemoglobin Concentration, Red Cell Distribution Width and Platelet Distribution Width showed no significant differences (p > 0.05) in all the groups. Among the malaria Parasite density groups (1000-5000mp/µl, 5001-10000mp/µl and >10000mp/µl), least lymphocyte count (1.34±0.21) was found in 5000-10000mp/µl, symptomatic patient. This difference was statistically significant (p<0.05). The value of minimum inhibitory concentration (Dilution) of 1000-5000 mp/µl of the asymptomatic subjects was statistically different (p<0.05) from the other malaria parasite density groups with the highest value (1.44±0.00). The Red Blood Cell and Haematocrit Count were higher, significantly (p<0.05), in >10000mp/µl of the asymptomatic group than the symptomatic and non-infected individuals.

Gender Influence on Haematological Parameters

Table 5 shows mean Haematological values of symptomatic patients, aymptomatic patients and non-infected control subjects in relation to sex. There were no significant differences in the values of White Blood Cell, Granulocyte Count, Lymphocyte Percentage, Minimum Inhibitory Percentage, Granulocyte Percentage, Platelet Volume and Platelet Distribution Width although the mean Value of the platelet count was higher in both male and female non-infected subjects (276.03±8.21, 255.88±12.72), respectively, than the other groups. There were generally significant difference in the mean Haematological value of Red Blood Cell (RBC), Haemoglobin (HB) and Hematocrit respectively.

The values of Platelet Concentration and Platelet Count (276.03±8.21, 0.22±0.01 and 255.88±12.72, 0.20±0.10) were significantly higher ($p<0.05$) in both normal male and female subjects than other groups. Also, corpuscular volume was higher statistically in the female asymptomatic group than the other groups ($p < 0.05$).

Table 3: Haematological Values (×±SEM) in Symptomatic, Asymptomatic and Non-Infected Subjects

	Normal	Symptomatic	Asymptomatic
White blood cell	6.43±0.14[a]	7.23±0.44 [a]	6.75 ±0.50[a]
Lymphocyte count	1.78±0.07 [a]	1.63±0.19 [a]	2.14±0.51[a]
Medium size count	0.71±0.03 [a]	0.65±0.07 [a]	0.85±0.09[a]
Granulocyte count	4.19±0.18 [a]	4.72±0.55 [a]	3.99±0.44[a]
Lymphocyte percentage	29.39±1.02 [a]	25.15±2.45 [a]	29.43±3.27[a]
Medium size percentage	11.38±0.47 [a]	10.16±0.90 [a]	11.32±1.27[a]
Granulocyte percentage	59.19±1.16 [a]	64.73±2.61 [b]	59.24±4.11[a]
Red blood cell count	4.45±0.06 [b]	4.14±0.21 [ab]	4.13±0.22[ab]
Haemoglobin	11.42±0.13[b]	8.81±0.44 [a]	11.01±0.58[b]
Haematocrit	35.41±0.43[b]	28.09±0.89 [a]	33.58±1.94[b]
Corpuscular volume	79.54±0.58[b]	75.04±2.22 [a]	80.38±1.94[b]
Corpuscular haemoglobin	25.69±0.21 [a]	24.97±1.57 [a]	26.49±0.67[a]
Corpuscular haemoglobin conc.	32.16±0.08 [a]	34.92±3.57 [a]	32.86±0.40[a]
Red cell distribution width	15.99±0.40 [a]	16.71±0.62 [a]	15.28±0.32[a]
Platelet count	269.57±6.93[b]	140.36±13.0[a]	123.63±6.99[a]
Platelet percentage	0.22±0.10[b]	0.11±0.01 [a]	0.10±0.01[a]
Platelet volume	7.82±0.13[a]	8.23±0.23 [a]	7.98±0.33[a]
Platelet distribution width	34.37±0.44[a]	36.78±0.60 [a]	36.68±1.24[a]

Table 4: Mean Haematological Values±Sem of Symptomatic, Asymptomatic and Non-Infected Subjectets in Relation To Sex

	Male Symptomatic	Male Asymptomatic	Male No Parasite	Female Symptomatic	Female Asymptomatic	Female no Parasite
WBC	7.21 ± 0.60[a]	6.44 ± 0.56 [a]	6.37 ± 0.16 [a]	7.69 ± 1.15 [a]	7.69 ± 1.15 [a]	6.58 ± 0.26 [a]
LYM	1.56 ± 0.26 [a]	2.14 ± 0.31 [a]	1.91 ± 0.09 [a]	1.67 ± 0.23 [b]	2.14 ± 0.58 [a]	1.72 ± 0.15 [a]
MID	0.61 ± 0.07 [a]	0.80 ± 0.11 [b]	0.71 ± 0.03 [b]	0.68 ± 0.12 [a]	099 ± 0.23 [b]	0.72 ± 0.15 [ab]
GRA	5.08 ± 0.74 [a]	3.66 ± 0.52 [a]	4.01 ± 0.12 [a]	3.82 ± 0.65 [a]	4.97 ± 0.62 [a]	4.55 ± 0.64 [a]
LY	22.87 ± 3.01 [a]	32.17 ± 3.67 [a]	30.56 ± 1.24 [a]	29.60 ± 4.15 [a]	21.20 ± 6.30 [a]	26.91 ± 1.76 [a]
MI	9.75 ± 1.06 [a]	11.78 ± 1.53 [a]	11.40 ± 0.56 [a]	10.92 ± 2.77 [a]	9.98 ± 2.42 [a]	11.34 ± 0.88 [a]
GR	67.44 ± 3.30 [a]	56.05 ± 4.54 [a]	57.88 ± 1.41 [a]	59.50 ± 3.77 [a]	68.83 ± 8.42 [a]	61.97 ± 2.01 [a]
RBC	3.92 ± 0.21 [b]	4.25 ± 0.06 [b]	4.45 ± 0.07 [b]	3.69 ± 0.56 [b]	3.78 ± 0.35 [bc]	4.45 ± 0.12 [b]
HB	9.31 ± 0.44 [b]	11.01 ± 0.74 [c]	11.56 ± 0.17 [c]	9.02 ± 0.41 [a]	11.00±0.90 [bc]	11.52 ± 0.31 [b]
HCT	28.96 ± 1.36 [b]	28.96 ± 1.37 [c]	35.46 ± 0.47 [c]	28.96 ± 1.37 [a]	33.67 ± 3.23 [b]	35.77 ± 0.94 [c]
CV	75.79 ± 2.20 [a]	75.79 ± 2.21 [b]	79.60 ± 2.15 [b]	75.79 ± 2.08 [a]	27.75 ± 103 [a]	25.54 ± 0.37 [ab]
CH	25.46 ± 2.18 [a]	25.46 ± 2.18 [a]	25.76 ± 0.026[a]	25.46 ± 2.18 [a]	27.75 ± 1.3 [b]	25.54 ± 0.37 [ab]
CHC	30.98 ± 0.60 [a]	30.93 ± 0.60 [b]	32.24 ± 0.10 [b]	30.93± 0.60 [a]	32.78 ± 0.30 [a]	31.99 ± 0.16 [ab]
RDWC	16.90 ± 0.83 [a]	16.89 ± 0.83 [a]	15.67 ± 0.35 [a]	16.90 ± 0.83 [a]	16.78 ± 0.19 [a]	16.66 ± 1.02 [a]
PLT	151.15 ± 17.60[a]	151.15± 17.60 [a]	276.03 ± 8.21 [b]	151.15 ± 17.60 [a]	112.25 ±8.29 [a]	255.88 ± 12.72[b]
PCT	0.12 ± 0.28 [a]	0.12 ± 0.02 [a]	0.22 ± 0.01 [b]	0.12 ± 0.12 [a]	0.10 ± 0.01 [a]	0.20 ± 0.10 [b]
PV	8.20 ± 0.28 [a]	8.20 ± 0.28 [a]	7.80 ± 0.14 [a]	8.20 ± 0.28 [a]	8.05 ±0.39 [a]	7.84 ± 0.28 [a]
PDWC	36.80 ± 0.73 [a]	36.81 ± 0.73 [a]	34.98 ± 0.51 [a]	36.80 ± 0.73 [a]	38.15 ±1.04 [a]	34.98 ±0.82 [a]

WBC- white blood cell; LYM - lymphocyte count; MID - medium size count; GRA - granulocyte count; LY - lymphocyte %; MI - minimum inhibitory %; GR - granulocyte %; RBC - red blood cell count; HB - haemoglobin count; HCT - haematocrit; CV - corpuscular volume; CH - corpuscular haemoglobin; CHC - corpuscular haemoglobin concentration; RDWC- red cell distribution width count; PLT- platelet count; PCT- platelet %; PV- platelet volume; PDWC- platelet distribution width count.

Table 5: Influence of *P. falciparum* density on haematological parameters of symptomatic and asymptomatic subjects

	1000-5000MP/µl Symptomatic	<1000MP Asymptomatic	5000-10000MP Symptomatic	5000-10000MP Asymptomatic	>10000MP Symptomatic	>10000MP/µl Asymptomatic
MP	4533.33±176.38[a]	4000.00±0.00[a]	7476.92±274.13b	7000.00±343.43b	12575.00±477.25c	13000.00±0.00c
WBC	7.15±1.53[a]	8.99±0.00[a]	6.77±0.82[a]	6.31±0.54[a]	7.69±0.73[a]	9.60±0.00[a]
LYM	1.61±0.21[b]	3.05±0.00[b]	1.34±0.21[a]	1.86±0.27[b]	2.28±0.55[b]	3.04±0.00[b]
MID	0.60±0.11[a]	1.44±0.00[b]	0.53±0.09[a]	0.78±0.12[a]	0.75±0.13[a]	0.75±0.00a
GRA	5.37±3.10[a]	4.50±0.00[a]	4.73±0.96[a]	3.96±0.50[a]	4.83±0.70[a]	5.82±0.00[a]
LY	29.133±9.70[ab]	33.90±0.00[a]	22.70±3.47[a]	27.01±3.45[a]	28.41±5.15[a]	31.60±0.00[a]
MI	9.43±3.01[ab]	16.00±0.00[b]	9.17±1.21[b]	10.79±1.43[ab]	10.31±1.85[ab]	7.80±0.00a
GR	61.47±12.42[a]	50.10±0.00[a]	68.23±4.01[a]	62.20±4.33[a]	61.28±4.72a	60.60±0.00[a]
RBC	3.35±0.38[a]	3.96±0.00[a]	3.69±0.22[a]	3.69±0.222[a]	3.90±0.35[a]	5.51±0.00[b]
HB	8.34±0.81[a]	11.50±0.00[b]	8.85±0.46[b]	10.55±0.63[b]	9.29±0.65[b]	14.80±0.00c
HCT	26.33±2.10[a]	35.36±0.00[a]	27.20±1.30[a]	32.22±2.17[a]	28.55±2.01[a]	44.94±0.00b
CV	78..67 ±9.17[a]	89.00±90.00[a]	75.83±2.74[a]	80.07±2.25[a]	76.25±3.32[a]	82.00±0.00[a]
CH	21.50±9.1.00[a]	29.10±0.00[a]	27.12±3.29[a]	26.43±0.79[a]	24.59±1.26[a]	26.80±0.00[a]
CHC	30.27±0.17[a]	32.50±0.00[a]	30.85±0.93[a]	32.91±0.50[a]	32.38±0.39[a]	32.90±0.00[a]
RDWC	17.53±1.83[a]	14.60±0.00[a]	17.16±1.20[a]	15.38±0.39[a]	15.90±0.58[a]	15.70±0.00[a]
PLT	240.67±68.93[c]	98.00±0.00a	133.77±19.74[b]	127.53±7.64[b]	118.62±7.11[b]	84.00±0.00[a]
PCT	0.27±0.06[b]	0.09±0.00[a]	0.08±0.081[a]	0.10±0.01[a]	0.09±0.07[a]	0.08±0.00b
PV	9.93±1.03[a]	9.10±0.001[b]	8.22±0.33[b]	7.72±0.34[b]	8.14±0.28[b]	9.20±0.00[b]
PDWC	41.53±2.49[a]	38.90±0.00[a]	37.10±0.77[a]	36.03±1.48[a]	36.13±0.68[a]	39.40±0.00[a]

MP- malaria parasite; WBC- white blood cell count;LYM- lymphocyte count; MID- medium size count; GRA- granulocyte count; LY- lymphocyte %; MI- minimum inhibitory %; GR- granulocyte %; RBC- red blood cell count; HB- haemoglobin count; HCT- haematocrit cou nt; CV- corpuscular volume; CH- corpuscular haemoglobin; CHC- corpuscular haemoglobin conc.; RDWC red cell distribution width count PLT- platelet count; PCT- platelet %; PV- platelet volume; PDWC- platelet distribution width count.

Discussion

Prevalence Characteristics

The overall demographic (age) prevalence characteristics of asymptomatic malaria parasite encountered in this study was 7.96%. This low prevalence might be attributed to low number examined. It is, however, evident from this study that there was significant association between prevalence of malaria parasite and age group. The age group 11years and above had the highest prevalence of asymptomatic malaria. This is as a result of acquired immunity. This is in agreement with the finding of Erhart *et al.* (2004), who reported significant association between the prevalence of asymptomatic malaria and age groups. Furthermore, findings of this study showed no significant difference in the prevalence of asymptomatic malaria parasite with respect to sex, which is in agreement with previous reports (Nwanjo and Opara, 2005).

Changes in Haematological Parameters

Haematological changes are some of the most common complications in malaria as they involve major cell lines, such as Red Blood Cells, leukocytes and thrombocytes (Maina *et al.,* 2010). Anaemia, thrombocytopaenia, and leukocytosis or leukopaenia in malaria have been reported, but the extent of these alterations varies with the level of malaria, endemicity, background haemoglobinopathy, nutritional status, demographic factors and malaria immunity (Price *et al*., 2001).

Changes in Leucocytes (WBC)

Leucocyte plays a vital role in defence against malaria. Leucocytes' change in malaria is variable and depend on many factors, such as acuteness of infection, parasitaemia, disease severity, state of the host immunity to malaria, and concurrent infection (Akhtar *et al.*, 2012). In contrast, divergent views have been expressed on total white blood cell count in malaria-infected subjects as leucopaenia has also been reported by some authors (Erhart *et al.*, 2004**;** George & Ewelike-Ezeani, 2011)) and leucocytosis has also been documented by other authors (Cheesbrough, 2009)

This study has shown, however, that there was no significant difference in the the Total WBC in both symptomatic and asymptomatic subjects compared to non-infected individuals. These findings are in agreement with those of other studies (Bashawri *et al.,* 2002; Chiwakata *et al*., 2002), which reported no significant difference in WBC between the ma-laria infected and non-infected groups. The different values may be associated with environmental factors, socio-economic status, or malaria immunity among other factors (Price *et al.,* 2001). In addition, there was no significant difference associated with total white blood cell count in relation to sex which is consistent with previous reports on haematological values that showed no significant gender variation (Dapper *et al*., 2009). Finding from this study also revealed no significant difference on the white blood cell count with

respect to parasite density. This is consistent with previous reports (Tchinda *et al.,* 2012).

White blood cell, including lymphocyte, minimum inhibitory concentration (monocytes, eosinophilis and basophilis), granulocyte percentage, showed no significant difference between the symptomatic, asymptomatic and normal subjects. These findings are in agreement with many earlier reports (Nwanjo & Opara, 2005; Maina *et al.,* 2010), but disagree with the finding of George and Ewelike-Ezeani (2011). Besides, there were no marked significant differences associated with values of White Blood Cell and its indices studied in this study in relation to sex and malaria density in symptomatic, asymptomatic malaria-infected and normal control subjects which is in conformity with previous haematological report values that showed no significant gender variation (Dapper *et al.*, 2009).

Changes in Red Blood Cells (RBCs) and RBC Indices.

For survival and reproduction, *Plasmodium* parasites need to infect the red blood cells of their human host (Maina *et al.,* 2010; George and Ewelike-Ezeani, 2011). Consequently, changes in the red blood cell indices are some of the commonest observations seen in malaria. Anaemia, which is a fall in haemoglobin level below the normal range for age, sex, race, or pregnancy status, is the most frequent outward manifestation of such changes. Malaria is the most common cause of severe anaemia in endemic area. Anaemia in malaria is believed to occur due to haemolysis of parasitized and non-parasitized RBCs, peripheral removal/sequestration of RBCs, and ineffective erythropoiesis (due to high circulating tissue necrotic factor (Akhtar *et al.,* 2012)

In this study, the RBC count, Hb level and Haematocrit count were significantly lower in the symptomatic subjects with *Plasmodium* infection. However, as observed elsewhere (Tchinda *et al.,* 2012), the red blood cell indices (Hb, MCV, MCH, MCHC and RDW) of all the groups in this study were normal. This could be attributed to the fact that the parasitaemia level observed was associated with milder biochemical changes. For example, a lower production of cytokines, less endothelial cell activation, milder changes in the coagulation profile, less sequestration and less haemolysis as opposed to severe malaria/complicated malaria.

Changes in Platelet count

Platelet abnormalities in malaria are both qualitative and quantitative. Platelets and coagulation factors are vital components of the extraordinary complex environment that surrounds flowing parasitised RBCs and the enclosing tubular vascular endothelium (Erhart *et al., 2*004). Because of that, a lot of research works have been dedicated to determining the effect of malaria on platelet homeostasis. What is now apparent from those studies is the fact that thrombocytopenia is a major complication of malaria (Maina *et al.,* 2010; Adedapo *et al.,* 2007); the magnitude of which is dependent on the parasite spores or disease severity. In light of the above *P. vivax* malaria infection, severe malaria have been associated with a more heightened and severe thrombocytopenia than falciparum infection and uncomplicated malaria. In this study, the mean platelet count in the tested groups was generally significantly lower than that of the non-parasitaemia group. This implies that the malaria infection observed in this study was associated with marked reduction in platelet. The inverse association of platelet count and malaria parasite density observed in this study corroborates findings of a study of semi-immune population in Thailand (Adedapo *et al.,* 2007). Children with low platelet counts were also likely to have anaemia as previously reported from a study in Nigeria (Adedapo *et al.*, 2007).

Thus, blood platelets appear to be good, but non-specific marker of malaria outcome in children, a finding that has already been reported (Erhart *et al., 2*004). The more decrease in blood platelet count in asymptomatic plasmodium infected subjects (children) may be explained by peripheral cell destruction and consumption and by a reduction in cell production.

Conclusion

This study concludes that haematological changes are associated with asymptomatic *Plasmodium* infection. These findings suggest that malaria parasite may affect haematological parameters of children adversely and has further revealed that *P. falciparum* uncomplicated malaria does not produce marked significant change in the total WBC count, differential WBC (Lymphocyte, neutrophilis, and eosinophilis) count, and RBC indices (Hb, MCV, MCH, and MCHC). However, significant changes were observed in the level of platelet count and found to be inversely proportional to the level of parasitaemia. By implication, platelet count determination can, therefore, be suggested among other tests, as a useful tool in monitoring the treatment response of patients to malaria therapy. In conclusion, the mild to severe changes, associated with the haematological values in malaria-infected children in this study, could be

attributed to environmental factors, endemicity and level of immunity among other factors. Thus, findings from this study will, therefore, add more detailed information to the limited knowledge about asymptomatic malaria and its influence on haematological parameters in Minna metropolis.

Recommendations

It is, therefore, recommended that the determination of platelet could be carried out in febrile or patient with pyrexia of unknown origin as the data/information could give a clue or further assistance in the diagnosis of malaria infection.

Special attention should be applied when interpreting haematological parameters and evaluating immune responses in children living in malaria endemic area and enrolled in vaccine trials.

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