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EFFECT OF MALARIA PARASITAEMIA ON HAEMATOLOGICAL PARAMETERS IN PATIENTS ATTENDING SELECTED HOSPITALS IN GOMBE STATE, NIGERIA

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ABSTRACT

Malaria is a major public health problem in most countries of the tropics and sub tropics. Malarial parasitemia causes wide ranging hematological and Biochemical alterations and may lead to life threatening complications if not diagnosed and treated in time. The aim of the study is to observe effects of Parasitemia on blood indices and liver function among patients attending six (6) selected hospitals in Gombe State, Nigeria. A total of 2400 patients attending the outpatient department of the six (6) selected hospitals were enrolled as test subjects. Venus blood was collected. Malaria parasite density was determined in various blood smears and analyzed for blood indices- Hb, PCV, total WBC, RBC, platelets. A total of 2400 individuals were investigated in this study. Out of the total number of study subjects from the six(6) randomly selected hospitals in Gombe state, 1799(74.9%) were positive for malaria parasite while 601(25.0%) were negative, the difference in prevalence was significant ($p<0.05$). Out of the 2400 individuals examined, 726(60.5%) were males while 1073(89.4%) were females, the difference in prevalence was significant ($p <0.05$). Prevalence in relation to age showed that <18 years had the highest prevalence 1001(41.7%) while age range above >40 years had the least prevalence of 106(4.4%) However, the differences between the age groups were statistically significant ($p<0.001$). Among the 1,799 malaria positive individuals, 1,122 (62.4%) had mild + infection, while 143(7.9%) had severe +++ infection. This is statistically significance at ($p<0.05$). According to sex, 440(60.9%), 203(27.1%) and 63(8.7%) males had mild +, moderate ++ and severe +++ infection respectively. On the other hand, 682(63.5%), 311(28.1%) and 80(7.5%) females had mild +, moderate ++ and severe +++ infection respectively, ($p<0.05$). Among the age groups, <18 years, had only mild + infection 599(59.8%), 296(29.6%) moderate ++ infection and 106(10.6%) severe +++ infection. Among the age group >40years, 63(59.4%) had mild infection, 27(25.5%) had moderate infection while, 16(15.0%) had severe infection. The differences in prevalence was statistically significant ($p<0.05$). Haematological parameters revealed that, the levels of PCV (27.9±4.09%), Hb (8.09±0.16g/dL), TWBCs (3.24±2.8/µl), RBC (2.71± 0.98 µl) and platelets (102.6±7.09 µl) showed significant ($p<0.05$) decrease, malaria infected patients compared to the uninfected patients. According to age, <18years had decrease in haematological values

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compared to 18-40years and >40years. In relation to sex, there was also a significant decrease in haematological parameters ($p<0.05$) in females compared to males.

Keywords: Malaria; Parasitaemia; Haematological; Biochemical and Gombe

INTRODUCTION

Malaria has been a major human health problem that threatens the lives of about 40% of the World's population causing morbidity and mortality worldwide (Adamu and Jigam, 2019). It is a vector borne infectious disease caused by a eukaryotic protista of the genus *Plasmodium*. The disease is transmitted by female *Anopheles* mosquitoes which carry infective sporozoite stage of *Plasmodium* parasite in their salivary glands (Akinleye, 2009). It is transmitted from person to person through the bite of a female *Anopheles* mosquito that is infected with one of the four species of *Plasmodium*: *Plasmodium ovale, Plasmodium falciparum, Plasmodium vivax and Plasmodium malariae.* Children under five years and pregnant women are particularly vulnerable to the disease due to their weaker immune systems (WHO, 2000). Malaria is an acute and chronic disease caused by obligate intracellular Protozoa of the genus *Plasmodium*. The zoological family Plasmodidae contains protozoan parasites found in the blood of birds, reptiles and mammals (Akinleye, 2009**).**

P. falciparum are found throughout tropical Africa, Asia and Latin America. *P vivax* is worldwide in tropical and some temperate zones. *P. ovale* is mainly in West Africa, while *P. malariae* is worldwide but very patchy in distribution (TDR, 2000). *P. falciparum* is responsible for about 80% of malaria infection in man and *P. vivax* is not seen among Africans especially West Africans due to the absence of the Duffy blood group (Afolabi *et al.,* 2019).

It is also a major public health problem in the world whose transmission is influenced by several inter-linking factors like climate, environment and demography. According to World Health Organization 2012 estimation, there were about 209 million cases of malaria in the world and Sub-Saharan Africa was the most affected region with estimated deaths of 627,000. Malaria remains one of the most pressing health problems in the world with an estimated 300-500 million cases annually of which 90% occurs in Sub Saharan Africa. The majority of malaria cases in Africa are due to *Plasmodium falciparum*, which is associated with mortality and morbidity (Yaya, 2011; Sissay and Gebreegziabhier, 2015; Sirak *et al*., 2016).

Malaria is endemic in 100 countries making about half of the world's population to be at risk. In 2017, an estimated 219 million cases of malaria occurred worldwide, compared with 239 million cases in 2010 and 217 million cases in 2016 (World Malaria Report, 2018). About 50% of Nigerian population is reported to suffer from at least one episode of malaria each year. Nigeria has been reported to have the greatest burden of the disease among the endemic countries in the world which account for 25% cases and 19% death due to malaria (World Health Organization, 2018; WMR, 2018).

Malaria is a disease that can be transmitted to people of all ages. The malaria parasite has a complex life cycle and transmitted to human by the bite of an infected female *Anopheles* mosquito which harbours the parasite. It is mainly caused by various species of *plasmodium* parasite (Al-Salahy *et al*., 2016). The major complications are caused by *Plasmodium falciparum* and *Plasmodium vivax* with *Plasmodium falciparum* being the more virulent. They are prevalent in all malaria areas in the country and their relative composition generally is 60% and 40% of the malarial cases, respectively. *Plasmodium falciparum* is the most causative agent of severe malaria in humans resulting in high mortality and morbidity. Based on Federal Ministry of Health report in 2009/2010,

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severe malaria infection was the leading cause of outpatient visit admissions, accounting for 14% and nearly 9% of admissions and it was among the ten leading causes of inpatient deaths in children and pregnant mothers in Nigeria (Yaya, 2011, Sirak *et al*., 2016).

Malaria develops via two phases: an exoerythrocytic and an erythrocytic phase. The exoeryrthrocytic phase involves infection of the hepatic system or liver, whereas the erythrocyte or red blood cell when an infected female anopheles mosquito pierces a person's skin to take a blood meal, sporozoites in the mosquito saliva enters the blood stream and migrate to the liver. Within minutes of being introduced into the human host, the sporozoites infect hepatocytes, multiplying asexually and asymptomatically for a period of 8-30 days (Dic-Ijiewere, 2018). Once in the liver, these organisms differentiate to yield thousands of merozoites, which following rupture of their host cells, escape into the blood and infect red blood cells, thus beginning the erythrocytic stage of the life cycle (Sumbele *et al.*, 2016). The parasite escapes from the liver undetected by wrapping itself in the cell membrane of the infected host liver cell. Within the red blood cells, the parasite multiply further, again asexually, periodically breaking out of their hosts to invade fresh blood cells. Several such amplification cycles occur (Sumbele *et al.*, 2016). Thus, classical description of waves of fever arises from simultaneous waves of merozoites escaping and infecting red blood cells. Some *P. vivax* and *P. ovale* sporozoites do not immediately develop into exoerythrocytic phase merozoites but instead produce hypozoites that remain dormant for period ranging from several months (6-12 months is typical) to as long as three years. After a period of dormancy, they reactivate and produce merozoites. Hypozoites are responsible for long incubation and late relapses in these two species of malaria (Esan, 2016).

Information on the association of malaria with impairment of organ function in Nigeria is scanty but very necessary because malaria is highly endemic in the country. The mortality and morbidity rates of the infection are also high especially in high risk groups such as children and pregnant women. Some haematological abnormalities, Renal failure, liver dysfunction and Anaemia may be indicative of severe malaria and therefore requires special attention. In Nigeria, cases of inadequate treatment of malaria is quite high among the urban and rural poor. This is because of the high level of self-medication that arise from difficulties inherent in weak health care system which make people to report to hospitals as a last resort. Majority of Nigerians, both and the urban and ruralareas in many countries of sub-Saharan Africa also use local herbs and plants as their main sources of medicines instead of complementary sources. Though some of these herbs may be very effective, others are not and the implication is that the impairment of organ functions which would have been transient, present only during the duration of the disease, will gradually progress to chronic organ dysfunction with its disastrous consequences. The aim of this study was to assess the impact of malaria parasitemia and its relation to some full blood count and liver function parameters among patients attending some selected hospitals in Gombe, Gombe State, Nigeria.

MATERIALS AND METHODS

Study Area

The study area will be Gombe State. The study will be carried out in State specialist Hospital Gombe, of Gombe state, 10º17'N, 11º10'E. Gombe is a state in north-eastern Nigeria, with its capital at Gombe. The state has an area of 20,265 km^2 and a population of around 1.8 million. The state is characterized by two distinct seasons, which are dry season (November to March) and wet season (April to October). The vegetation of Gombe state can be described as Sudan

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Savanna with open grassland which dries up during the dry season. Gombe State shares boundaries with Yobe State to the North, Adamawa and Taraba States to the South, Borno State to the East, and Bauchi State to the West. Gombe State is divided into eleven local government councils. The local councils are: Gombe, Billiri, Akko, Balanga, Shongom, Kaltungo, Funakaye, Dukku, Yamaltu/Deba, Bajoga, and Kwami. (Southern part in bold). The people of Gombe south are mainly farmers. They produce both food and cash crops. Among its food crops are yam, cassava, maize, millet, sorghum, cowpea, tomato, groundnut, while cottons are produced for cash. Its people also keep cattle, goats, sheep, horses, and donkeys and practice the traditional crafts of weaving and dyeing cotton (Annon, 2003).

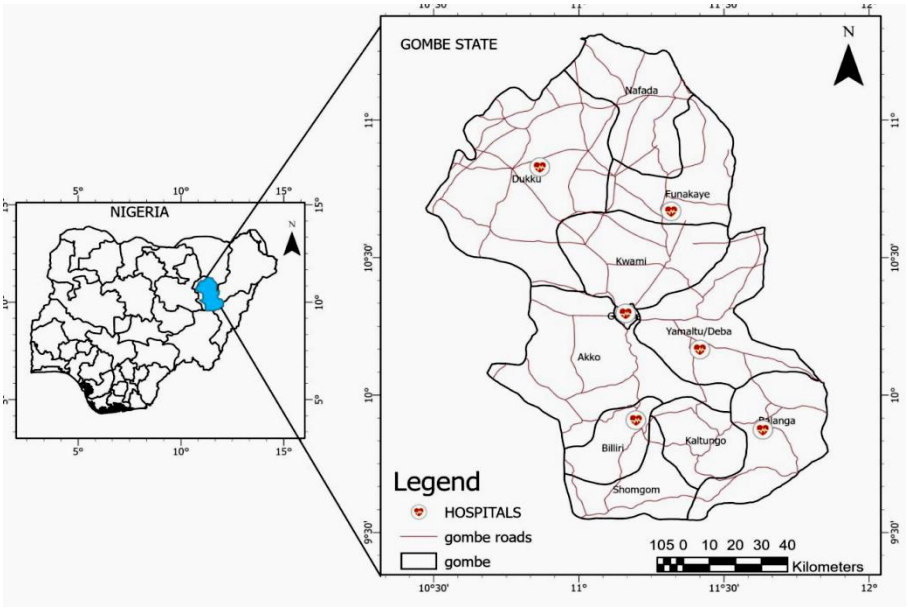

Figure 1: Map of Gombe Showing the Six (6) Selected study Hospitals in Gombe State

Study Design

The study was a hospital base study conducted in outpatient's clinics in six (6) selected Hospitals in Gombe state Nigeria. There are eleven (11) local Government area in Gombe state, namely; Gombe, Dukku, Nafada, Funakaye, Kwami, Billiri, Kaltungo, Shongom, Balanga, Deba and Akko. Out of the thirteen (9) Health facilities in Gombe State, six (6) health facilities were picked at random, namely; Gombe specialist Hospital, Billiri general Hospital, Balanga general Hospital, Dukku general Hospital, Bajoga general Hospital and Deba General Hospital.

Target Population and Sample Size

A total of two thousand four hundred (2,400) were collected, four hundred (400) samples each from the six (6) selected hospitals. All male and female individuals between the ages of 0-55 years with malaria infection and normal subjects referred to the laboratory unit of the selected health facilities in Gombe, Gombe state were recruited in this study.

Sample Size Determination

The sample sizes for the different study sites was calculated as prescribed by WHO (2010). The number of study subjects selected to represent the study population was calculated

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using the statistical formula shown below. It is important to make inferences based on the findings from the sample. Determined by using single population formula 95 % CI and 5% marginal sample error assumed to be = 0.05, Z = 1.96.

$$n = \frac{[Z_{1-\alpha/2}]^2 \ P(1-P)}{d^2}$$

Where Z, P, d, n, and α represents Z1-α/2 = the standard normal variable at (1-α) % confidence level and α (level of significance) is mostly taken to be 5%.

• 95% confidence level is used Z = 1.96

d = the margin of sampling error tolerated.

P = Estimate of the prevalence rate severe malaria patients in the population and

n = Minimum sample size required for very large population (≥ 10,000) is 400.

Selection Criteria for Subjects

Inclusion criteria

Participants of this research were individuals attending the general outpatient department of the six (6) selected hospitals in Gombe state within the age of 0-55 years. Generally, all subjects comprising males and females whose blood samples were confirmed positive or negative for the presence or absence of malaria parasites were recruited for the study.

Ethical Clearance

This study was revised and approved by the Gombe State ministry of Health research ethics committee. All Individuals who participated in this study were informed about all relevant aspects of the study including its aim, procedures, potential risk and hazards. A signed informed consent was obtained and assurance given that the participation in the study was strictly voluntary.

Parasitological Examination

Collection of Blood Sample

Approximately 10ml each of venous blood samples was collected by vein puncture from the antecubital vein of the forearm of each patient . Blood samples were placed in plain containers and centrifuged. Samples were centrifuged and the sera collected for analysis. The sera were harvested into micro tubes and stored immediately at -20°C.

Preparation of Thick Films Blood Smears for Microscopy

This involved making thick blood films on clean grease free glass slides, allowed to air dry and stained with prepared Giemsa stain for 30 minutes. The Giemsa stain was prepared by diluting stock Giemsa stain in buffered water prior to use. Stained slides were rinsed in clean water and allowed to air dry before examination under a microscope using X100 objective lens. Chromatin of malaria parasite was stained dark red and cytoplasm stained blue with Giemsa's stain. The presence of malaria parasite, identification of the species of human parasites and relative malaria parasite count in each blood sample was determined from the Giemsa-stained thick films and Leishman stained thin blood films. Malaria Parasitaemia was confirmed by microscopic examination using X100 objective lens (oil immersion lens). A slide was scored as negative when 100 high power fields had been examined for about 30 minutes without seeing any parasites. The amount of relative parasite count (Occurrence) in positive smears was done using a simple code from one to four crosses (+++++), although none of the subjects had ++++. Malaria Parasitaemia occurrence was graded as; + = 1 – 10 parasites per 100 thick film field; ++ = 11 – 100 parasites per 100 thick film field; +++ = 1 – 10 parasites per single thick film field; ++++ = more than 10 parasites per

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single thick film field after staining for 30 minutes as described by (Cheesbrough, 2010).

parasites / ul of blood = Number of observed asexual parasites

200 (Number of leucocytes counted) X Total WBC count / ul

The WHO grades malaria parasitaemia upon examination of slide through battlement method as follows

I. 1-10 parasites per 100 high power fields.....+ or (PF^{+1})

II. 11-100 parasites per 100 high power fields.....++ or (PF^{+2})

III. 1-10 parasites per high power field.....+++ or (PF^{+3})

IV. >10 parasites per high power field.....++++ or (PF^{+4})

Haematological Analysis

Whole blood samples were collected in EDTA tube for determination of hematological parameters including haemoglobin (Hb) concentration, tWBC count, RBC, platelets, and packed cell volume (PCV) using automated (SYSMX.KX-21n) hematology analyzer.

RESULTS

Characteristics of Study Population

A total of 2400 individuals were investigated in this study. Out of the total number of study subjects from the six(6) randomly selected hospitals in Gombe state, 1,799(74.9%) were positive for malaria parasite while 601(25.0%) were negative, the difference in prevalence was significant ($p<0.05$). Out of the 2400 individuals examined, 726(60.5%) were males while 1073(89.4%) were females, the difference in prevalence was significant ($p <0.05$) (Table 1).

Table 1: Socio-demographic Information of Subjects

Variable	Frequency	Percentage (%)
Gender		
Male	1204	50.1
Female	1196	49.8
Age Group (Years)		
<18	1237	51.5
18-40	941	39.2
>40	222	9.3
Education		
Primary and below	1560	65.0
Secondary	433	18.0
Tertiary	192	8.0
Non-formal	215	8.9
Occupation		
Farming	1780	74.2
Public Service	40	1.7
Students	320	13.3
Business/Trading	41	1.7
Unemployed	219	9.1

Prevalence in relation to age showed that <18 years had the highest prevalence 1001(41.7%) followed by the age range 18-40 years 692(28.8%) while age range above >40 years had the least prevalence of 106(4.4%) (Table 2). However, the differences between the age groups were statistically significant ($p<0.001$). Among the age groups, <18 years, had only mild + infection 599(59.8%), 296(29.6%) moderate ++ infection and 106(10.6%) severe +++ infection. Among the age group 18-40years, 460(66.4%) had mild infection, 191(27.6%) had moderate infection while 41(5.9%) had severe infection. Among the age group >40years, 63(59.4%) had mild infection, 27(25.5%) had moderate infection while, 16(15.0%) had severe infection.

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Table 2: Prevalence of Malaria Infection According to Sex of Patients Attending the selected Hospitals in Gombe State

Sex/Hospital	No. Positive(%)	No. Negative(%)	Prevalence (%)	P-Value
Specialist Hosp.				
Male	126(40.8)[a]	74(81.3)	63.0	<0.05
Female	183(59.2)[b]	17(18.7)	91.5	
Billiri Gen Hosp.				
Male	74(31.2)[a]	126(77.3)	37.0	<0.05
Female	163(68.8)[b]	37(22.7)	81.5	
Deba Gen Hosp.				
Male	124(41.6)	76(74.5)	62.0	<0.05
Female	174(58.3)	26(25.5)	87.0	
Balanga Gen Hosp.				
Male	138(42.2)	62(86.3)	69.0	<0.05
Female	189(57.8)	11(15.1)	94.5	
Bajoga Gen Hosp.				
Male	147(45.8)	62(75.6)	73.5	<0.05
Female	174(54.2)	20(24.4)	94.5	
Dukku Gen Hosp				
Male	117(38.1)	83(89.2)	58.5	<0.05
Female	190(61.8)	10(10.8)	95.0	
Total	**1799**	**601**	**74.9**	

Table 3: Prevalence of Malaria Infection According to Age of Patients Attending the Selected Hospitals in Gombe State

Age/Hospital	No. Positive	No. Negative	Prevalence (%)	P-value
Gombe Specialist Hosp.				
<18	189(61.2)[a]	54(59.3)	47.3	<0.001
18-40	105(33.9)	31(34.1)	26.3	
>40	15(4.9)	06(6.6)	3.8	
Billiri General Hosp.				
<18	120(50.6)	79(48.5)	30.0	<0.001
18-40	98(41.4)	74(45.4)	24.5	
>40	19(8.0)	10(6.1)	4.7	
Deba General Hosp.				
<18	151(50.6)	34(33.3)	37.8	<0.001
18-40	138(46.3)	52(51.0)	35.5	
>40	09(3.0)	16(15.7)	2.5	
Balanga General Hosp.				
<18	188(57.5)	26(35.6)	47.0	<0.001
18-40	125(38.2)	25(34.2)	31.3	
>40	14(4.3)	22(30.1)	3.5	
Bajoga General Hosp				
<18	173(53.8)	28(35.4)	43.3	<0.001
18-40	128(39.9)	20(25.3)	32.0	
>40	20(6.2)	31(39.2)	5.0	
Dukku General Hosp.				
<18	180(58.6)	20(21.5)	45.0	<0.001
18-40	98(31.9)	42(45.2)	24.5	
>40	29(9.4)	31(33.3)	7.3	
Total	**1799**	**601**		

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Table 4: Prevalence of Malaria Parasitaemia Infection According to Sex of Patients Attending the Selected Hospitals in Gombe State

Sex/Hospitals	No. Positive	Mild (+)	Moderate (++)	Severe (+++)	P-value
GombeSpecialist Hosp.					
Male	126(40.8)[a]	75(39.8)	38 (49.35)	13 (28.6)	<0.0001
Female	183(59.2)[b]	113(60.1)	39(50.6)	31 (53.6)	
Billiri General Hosp.					
Male	74(31.2)	41(36.2)	25(34.6)	08(66.0)	<0.0001
Female	163(68.8)	122(60.5)	33(48.7)	04(45.7)	
Deba General Hosp.					
Male	124(41.6)	75(24.5)	29(17.7)	0(0)	<0.0001
Female	174(58.3)	110(56.3)	57(68.1)	07(13.6)	
Balanga General Hosp.					
Male	138(42.2)	89(58.3)	30(67.8)	19(26.7)	<0.0001
Female	189(57.8)	127()	56()	06()	
Bajoga General Hosp					
Male	147(45.8)	89(45.6)	47(56.4)	11(22.0)	<0.001
Female	178(54.2)	114(75.8)	50(56.3)	14(23.1)	
Dukku General Hosp.					
Male	117(38.1)	71(68.0)	34(54.3)	12(34.2)	<0.0001
Female	190(61.8)	96(87.5)	76(98.5)	18(35.8)	

Test values in a column with the different superscript are significantly different ($p<0.05$)

Table 5: Prevalence of Malaria Parasitaemia Infection According to Age Among Patients Attending the Selected Hospitals in Gombe State

Age/Hospitals	No. Positive (%)	Mild(+) (%)	Moderate (++) (%)	Severe (+++) (%)	P-value
Gombe Spec Hosp					
<18	189(62.2)	115	38	36	p<0.0001
18-40	105(33.9)	63	36	06	
>40	15(4.9)	10	03	02	
Billiri Gen Hosp					
<18	120(50.6)	79	33	08	p<0.0001
18-40	98(41.4)	95	19	04	
>40	19(8.0)	09	06	04	
Deba Gen Hosp					
<18	151(50.6)	98	35	18	p<0.0001
18-40	138(46.3)	81	50	07	
>40	09(3.0)	06	01	02	
Balanga Gen Hosp					
<18	188(57.5)	128	42	18	p<0.0001
18-40	125(38.2)	78	41	06	
>40	14(4.3)	10	03	01	
Bajoga Gen Hosp					
<18	173(53.8)	100	63	10	p<0.0001
18-40	128(39.9)	89	30	09	
>40	20(6.2)	14	04	02	
Dukku Gen Hosp					
<18	180(58.6)	79	85	16	p<0.0001
18-40	98(31.9)	74	15	09	
>40	29(9.4)	14	10	05	
Total					

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Table 6: Comparison of Haematological Parameters in Relation to Sex of Patients Attending the selected General Hospitals in Gombe State

	PCV	Hb	TWBC	Platelets	RBC	p-value
Gombe Specialist Hospital						
Male	32.4`±0.61[a]	11.3±0.61[a]	3.41±3.01[a]	145.6±0.07[a]	3.81±3.41[a]	>0.01
Female	27.1±1.28[a]	10.34±0.68[a]	3.29±0.99[a]	130.4±0.09[a]	3.01±0.00[a]	
Billiri General Hospital						
Male	33.4±0.09[a]	13.9±0.00[a]	3.84±1.40[a]	150.2±0.01[a]	4.01±1.11[a]	>0.01
Female	28.1±3.01[a]	10.8±1.00[b]	3.10±0.02[a]	148.1±0.08[b]	3.89±2.99[a]	<0.01
Deba General Hospital				`		
Male	32.8±1.22[a]	11.13±0.01[a]	3.75±1.82[a]	149.4±0.04[a]	3.72±1.4[a] 1	>0.01
Female	28.3±0.17[a]	9.14±0.66[a]	3.25±3.33[a]	134.8±0.01[b]	3.60±2.14[a]	
Balanga General Hospital						
Male	33.3±3.41[a]	13.0±1.24[a]	3.89±0.07[a]	150.0±0.40[a]	4.11±0.29[a]	>0.01
Female	27.4±1.34[a]	11.4±0.01[b]	3.1±0.02[a]	147.6±0.44[a]	3.61±0.00[a]	<0.01
Bajoga General Hospital						
Male	31.4±0.01[a]	11.3±3.49[a]	3.04±0.66[a]	140.6±0.00[a]	3.21±1.34[a]	>0.01
Female	25.4±0.66[a]	8.6±2.44[a]	3.01±0.00[a]	110.1±0.68[b]	3.00±0.14[a]	
Dukku General Hospital						
Male	30.1±0.16[a]	11.3±0.61[a]	3.14±1.23[a]	130.2±0.49[a]	3.29±1.14[a]	>0.01
Female	25.1±0.48[a]	8.14±0.66[a]	3.01±1.34[a]	109.1±0.64[b]	3.12±1.38[a]	

DISCUSSION

The result of this study showed that the overall prevalence of *Plasmodium* parasite was 1799(74.4%). This indicated that malaria is endemic in the area as it is in every other part of the country. The finding agreed with several reports from both within and outside the country (Afolabi, 2010, Salako *et al.,* 2012 , Kalu *et al*., 2012 and Ademowo *et al .,* 2016). These researchers all reported high prevalent rates in their respective studies and this agreed with Bassey and Izah (2017) that malaria infection is holo-endemic in Nigeria and widespread in tropical and subtropical regions of Africa, Asia and America. These high rates can be one of the reasons for high mortality rates in these areas especially in children and pregnant women. Infection is acquired wherever there are human hosts carrying the parasites and sufficient *Anopheles* mosquitoes, together with conditions of temperature and humidity that favour the development of parasites in the mosquitoes. Such factors are readily available in the tropics, hence, the high prevalent rates in these regions. However, the prevalent rate of malaria parasitaemia in this present study is much higher than the reports referred to above and those of (Snow, 2018 and Adeyemo *et al.,* 2020) who reported 34.1%, 35.8% and 40% parasitaemia respectively. The wide differences between the result of the present study and those of earlier studies may be attributed to the decreased awareness about the infection and the decreased use of insecticide treated nets and similar measures in the prevention of malaria.

Gender-wise, the study showed that there was sex difference ($p<0.001$) in infection as same number of both sexes was infected. This agreed with studies by Akujuwor, *et al;* 2013, Chandra and Chandra, 2013, Adefioye *et al*., 2017, Ani, 2015, and Afolabi *et al.*, 2019). All these researchers reported higher prevalences in females than males. This could be due to the fact that the females are more exposed more than the males especially during pregnancy. Their immunity tends to be lower. Agyepong, (2020) attributed that sex differences in malaria infection can be due to genetic and hormonal factors. However, in most of the studies that reported sex differences, such differences were not statistically significant. The present study is, however, in agreement with the findings of Sirak (2016) who

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reported that sex did not affect the prevalence of malaria.

In the present study, the age range <18 years had the highest prevalent rate of 41.7% followed by 18-40 years while the age range 66-72 years had the least infection ($p<0.001$). This is also similar to the findings of Aju-Ameh *et al*. (2016), Erlhabor et al. (2014) which all reported decline in prevalence by age. This also agreed with the report of Ani (2015) that children in the first decade of life had the highest prevalence of malaria. The most likely reason for decline in prevalence by age is that older individuals may have developed anti-malaria immunity after many years of chronic expose to mosquito bites and malaria infection. Immunity has important effects on the transmission of the disease by reducing the level of parasitaemia after infective bites and increasing ten folds the rate of clearance of parasitaemia (Ademowo, 2019). Malaria infection was more prevalent in younger individuals because of their relatively less developed immunity to the infection than the older individuals.

Analysis of data on the categories of malaria parasite prevalence in this study, revealed that majority of the infected individuals had mild infection which is statistically significant ($p<0.001$). For example, 1122(63.8%) positive individuals had mild infection. Furthermore, the mean parasite density of the 1122 positive individuals is 2361.89 ± 857.55p/µl. This shows that majority of the infected individuals had low parasite densities. This could be attributed to natural immunity derived by these individuals from persistent attacks of malaria. This is in agreement with previous findings of Facer (2014) stated that in hyper-endemic areas, the disease is mild and asymptomatic especially in the adults. Therefore age of the host may represent natural or acquired resistance and hence can play a role in the severity of the disease produced.

The present study investigated the effect of malaria parasitaemia on hematological and biochemical parameters in patients with malaria. The results showed that, the values of AST and Glucose were significantly ($p<0.05$) higher in patients with parasite density <5000 parasite/µl compared to the uninfected patients, but the other parameters showed no significant difference between the two groups at this level of parasitemia. While in patients with parasite density 5001-10,000 parasite/µl, the significant decreased of PCV, Hb, RBC and TWBCs, were reported, compared to Uninfected patients. Many authors have reported different parameters, alternated by malaria, were influenced by the levels of parasitaemia (Garba *et al*., 2015, Gayawan, *et al*., 2014; Hadera, 2017, Izah *et al*., 2017 and Kalu *et al*., 2012). The present study suggested that, parameters were affected by malaria disease at parasite density between 5000- 10,000 parasite/µl more than less or higher densities.

CONCLUSION

Malaria prevalence was high in the study area as in every other part of the country in particular and the tropical region in general. Sex did not determine the trend of malaria parasite infection in this study. There was decline in prevalence as age increased. Haematological (Full blood count) parameters were seen associated with mild, moderate, and severe parasitaemia infection. Greater percentage of the infected individuals had mild infection which showed that malaria is both endemic and well tolerated in the study area. Hematological markedly altered in patients with malaria.

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